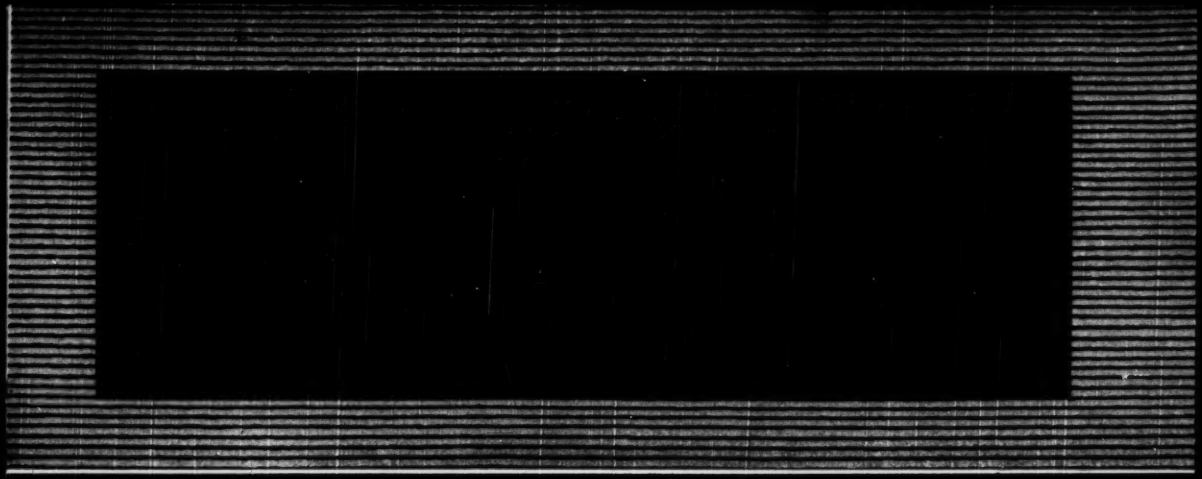

· OCTOBER 1950 ·

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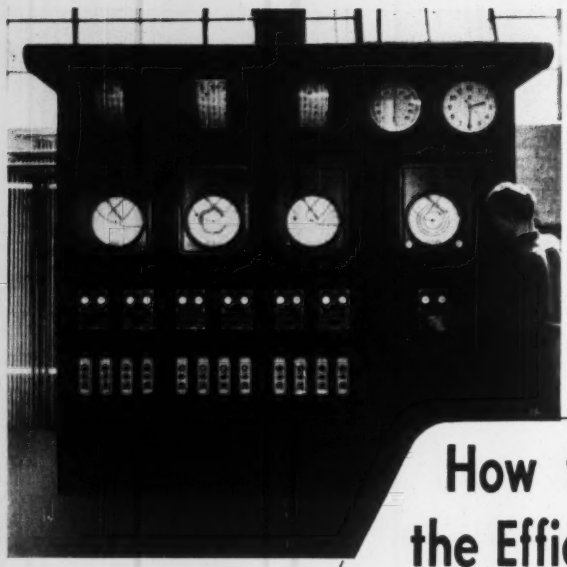


These Bailey Boiler Controls at the Chicago Pneumatic Tool Company's new plant in Utica, N. Y. insure efficient operation of three 25,000 lb per hour, 100 psi, spreader stoker-fired boilers

How to INCREASE the Efficiency of YOUR BOILER-ROOM DOLLAR

Before you get steam you've got to spend dollars—so dollars are a form of energy.

And if your boiler-room dollars are invested in equipment that isn't working efficiently, economically, your "investment" is poor.

That's where co-ordinated controls by Bailey can help. Here's why they'll increase your "boiler-room investment efficiency":

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better "boiler-room investment" efficiency —for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

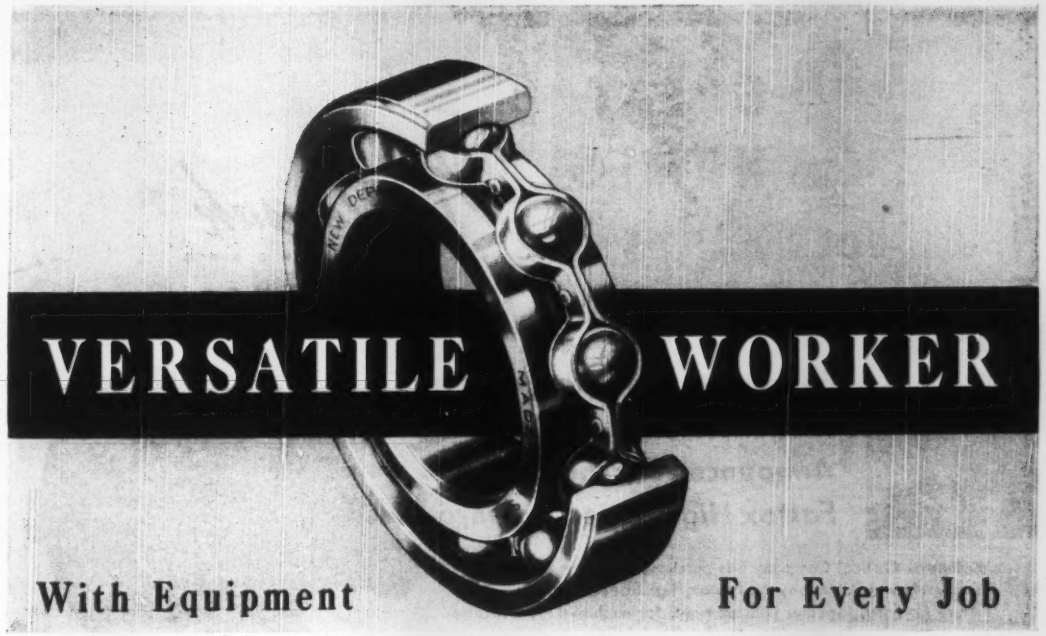
A-111-0

BAILEY METERS

BAILEY METER COMPANY

1026 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS



With shield on one side for protection against abrasive dirt.

With shields on both sides to keep dirt out and lubricant in.

With snap ring for location of bearing in housing.

With snap ring and either one or two shields as required.

With contact seals, lubricated for long life without attention.

A standard New Departure single row ball bearing may be had with about a dozen different combinations of seals, shields, snap rings, etc., to simplify mounting, lubrication or enclosure—in short it may be had with the equipment to do each specific job best.

But basically you always have one of the most useful and dependable workers ever devised—taking radial loads and thrust loads from either direction—locating parts accurately and permanently -all in one unit requiring no time-wasting adjustment or other attention.

Nothing Rolls Like a Ball

NEW DEPARTURE BALL BEARINGS

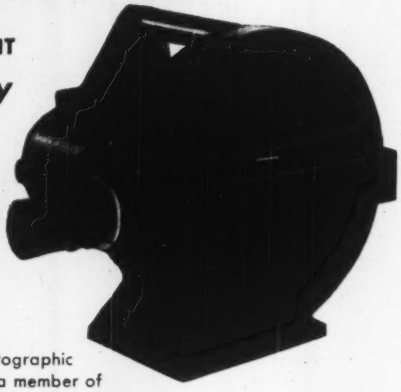
NEW DEPARTURE · DIVISION OF GENERAL MOTORS · BRISTOL, CONNECTICUT

MECHANICAL ENGINEERING, October, 1950, Vol. 72, No. 10. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations

2 GREAT NAMES JOIN HANDS . . .

Wollensak ..... FASTAX

Edward A. Springer, PRESIDENT *Wollensak Optical Company Announces Purchase of Fastax High Speed Camera*



Wollensak Optical Company has purchased outright from Western Electric Company the Fastax High Speed Motion Picture Camera, together with all rights for exclusive manufacture and distribution. By acquiring the Fastax, Wollensak will be able to render an immeasurable service to many industries and scientific laboratories.

The Fastax Cameras, part of our new Industrial and Technical Photographic Division, will be headed by John H. Waddell, for twenty-one years a member of the Technical Staff of Bell Telephone Laboratories. Under his guidance the Fastax was perfected. Mr. Waddell has also been photographic consultant to both the Army and Navy, and was a consultant to the Army Air Force on the Bikini Experiments. He will personally attend to all inquiries regarding the Fastax and to all problems of high speed photography.

E. A. Springer

ACQUISITION OF FASTAX HIGH SPEED CAMERAS ANOTHER EXAMPLE OF WOLLENSAK LEADERSHIP IN THE PHOTOGRAPHIC FIELD

The Fastax, a continuous moving film type camera, is rated not only as the highest speed commercial camera of its type made, but also the most versatile device for recording high speed motion, of either a repetitious or transient nature. Produced in three sizes—to accommodate 8mm, 16mm and 35mm film—it takes motion pictures at a speed of 150 to 10,000 frames a second with an exposure time of 1/50,000 of a second. The purpose of the Fastax is to make available to engineers and scientists a tool for the close study of high speed phenomena now beyond the perception of the human eye.

Wollensak is proud to have Fastax in its line of products . . . particularly since the camera's inception it has been equipped with Wollensak optics.

Wollensak
MEANS FINE LENSES
OPTICAL CO., ROCHESTER 21, N. Y.

- DISTRIBUTOR IN THE UNITED STATES
  GraybaR ELECTRIC COMPANY
  420 Lexington Avenue, New York 17, N. Y.
  Or Your Local Branch
- DISTRIBUTOR FOR CANADA AND NEWFOUNDLAND
  Northern Electric COMPANY LIMITED
  1620 Notre Dame Street, W., Montreal, P. Q., Canada
  Or Your Local Branch
- FOREIGN DISTRIBUTOR (Except Canada and Newfoundland)
  Westrex Corporation
  111 Eighth Avenue, New York 11, N. Y., U.S.A.

They told him Stainless Steel would outlast the car

IF you were to make a test of it, Allegheny Metal trim and fasteners actually *would* stay on the job, perennially bright and strong, until the rest of the car crumbled into dust. But the main point is that the use of stainless steel adds little or nothing to the cost of the car, yet vastly improves its appearance, value and easy cleaning qualities during all of the vehicle's useful life.

What's more, nothing else can do the job as well. No other metal now commercially available is as strong, as corrosion and heat-resistant and as hard-surfaced—taking all these virtues together—as stainless steel. That's why Allegheny Metal gets the call for so many uses in transportation equipment, aircraft and other essential industries where lasting, dependable service is required under really tough conditions. When the chips are down, as at present, stainless steel is vital to the national interest.

We're continuing to spend many millions of dollars to add more production of Allegheny Metal and other alloy products to the great increases we've already made. We're ready, too, to assist fabricators in finding better ways of using stainless steel, to make the supply go as far as possible. *Call us in to work with you.*

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. . . . the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Metal are carried by all Ryerson Warehouses.

W&D 3269

You can make it **BETTER** with

Allegheny Metal

AL TIME-TESTED STAINLESS STEEL

CONSOLIDATED'S

NEW

- LOW COST
- HIGH QUALITY
- COMPACT DESIGN

Recording OSCILLOGRAPH

A PRECISION RECORDING INSTRUMENT TO MEET YOUR BUDGET

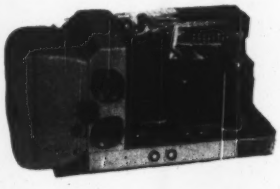
- Choice of 9- or 14-trace capacity
- 10 quick-change record speeds (¼" to 100" per sec.)
- Easily detachable record magazine (capacity 125 ft. of 5" paper)
- Uses standard Consolidated Series 7-200 Galvanometers
- Automatic record numbering
- Two static reference traces
- Record footage indicator
- Precision timing system (.01- and .10-sec. timing lines)
- Constant-temperature galvanometer block
- Simultaneous viewing and recording
- Choice of a-c (115 v, 60 cycle) or d-c (24-28 v) models
- Compact design (dimensions: 9" x 9½" x 19½", weight: 48½ lbs.)
- 4-point shockmount base (optional)
- Trace identification (optional)

Designed to meet the needs of those who require the utmost in performance, but who must operate on a limited budget, the new Consolidated Recording Oscillograph, Type 5-116, is engineered to the precise standards of the larger Consolidated Oscillographs—yet is drastically lower in price.

Using the widely accepted Consolidated Series 7-200 Galvanometers—which offer a sensitivity and frequency for every job—the 5-116 Oscillograph produces records possessing quality and accuracy equal to those of the finest instruments heretofore available.

Compare the 5-116 with any oscillograph now available. Regardless of the size of your budget, you can't find a better value.

For further information write for Bulletin CEC-1521-X4



Removable case assures maximum accessibility. Rugged construction maintains accurate alignment of components.

NEW AMPLIFIER A new, low-cost, 4-channel, 3-kc Carrier Amplifier, Consolidated Type 1-118, is now available as a companion to the 5-116 Oscillograph, making a versatile recording system for the static-dynamic measurement of strain, pressure, and acceleration. Frequency range is flat from 0-500 cps. For further information write for Bulletin CEC-1522-X4

CONSOLIDATED ENGINEERING CORPORATION

Analytical Instruments for Science and Industry

620 NORTH LAKE AVENUE • PASADENA 4, CALIFORNIA

Quiet, Durable G.S. Gearing Drives

THE NEW

HAMILTON BEACH *Food Mixer*

Food Mixers take (and often hand out) a terrific beating! Operating at high speeds and under ever-varying loads, the Gearing must be of the finest quality . . . and it must be uniformly made to the most exacting specifications. That's why HAMILTON BEACH uses G. S. Fractional Horsepower Gearing for their remarkable new Food Mixer.

HAMILTON BEACH is another of the *many* illustrious names that appear on fine products with Gearing by G. S. In fact, wherever smooth, quiet, durable Small Gear performance is required, *it's a job for G. S!* Here, you get *top talent* . . a big organization seasoned by over 30 years of specializing in the design and economical *production-run* manufacture of Fractional Horsepower Gearing exclusively!

Step up the quality and the uniformity of the Small Gearing you buy. Submit drawings or ask our skilled engineers for suggestions, ideas and cost estimates. This will not obligate you in any way. Find out today why so many of our country's biggest users rely on G. S. for all of the Fractional Horsepower Gearing they need!

SEND FOR FREE *new 6-page folder which illustrates and describes G. S. facilities, Small Gearing and applications together with handy charts for those who specify Gearing from 12 D. P. and finer. Will you ask for it on company stationery, please?*

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WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

it's light...it's strong

it's the space-saving choice

FOR DRIVE AND CONVEYOR SERVICE

BALDWIN-REX DOUBLE PITCH ROLLER CHAIN!

Light weight . . . strength . . . compactness, Baldwin-Rex Double Pitch Roller Chain combines all these important advantages for your drives and conveyors.

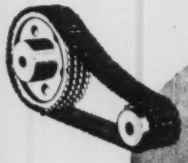
This economical chain is made of standard Baldwin-Rex roller chain round parts . . . pins, bushings, rollers, . . . but with plates that are double the pitch of corresponding standard roller chain. You get the same highly finished parts, the same basic advantages, the same long life and high strength of standard roller chain, all at a lower cost per foot.

Where your speeds are slow to medium . . . where centers are long or where space is limited, Baldwin-Rex Double Pitch Chain is your economical answer. In many applications, it can be used with cast tooth sprockets . . . an important cost-cutting advantage.

Baldwin-Rex Double Pitch Roller Chains are available in three basic styles as illustrated below. A wide variety of standard attachment links is available for these chains. For complete details, mail the coupon at right for your copy of Bulletin No. 49-3.

Baldwin-Rex Double Pitch Chain with Figure 8 Plates for drive service.

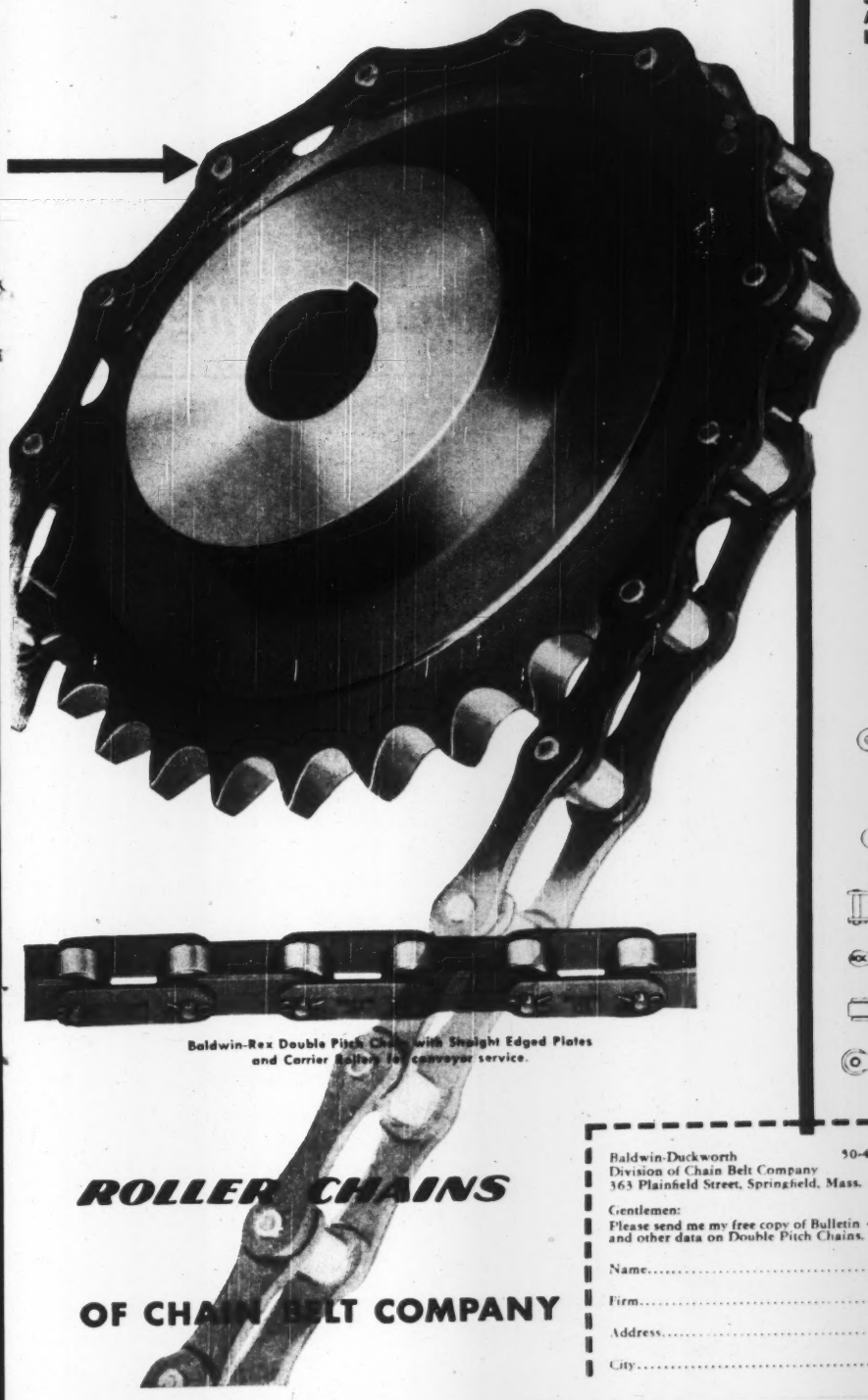
Baldwin-Rex Double Pitch Chain with Straight Edged Plates for conveyor service.



BALDWIN·REX

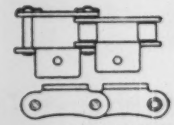
BALDWIN-DUCKWORTH DIVISION

a complete line from ¼ to 2½-inch pitch

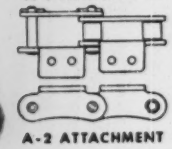


Baldwin-Rex Double Pitch Chain with Straight Edged Plates and Carrier Rollers for conveyor service.

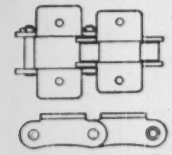
STANDARD ATTACHMENT LINKS



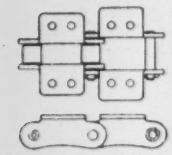
A-1 ATTACHMENT



A-2 ATTACHMENT



K-1 ATTACHMENT

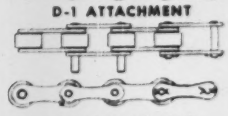


K-2 ATTACHMENT

M-0 ATTACHMENT

MM-0 ATTACHMENT

D-1 ATTACHMENT



D-3 ATTACHMENT

ROLLER CHAINS

OF CHAIN BELT COMPANY

Baldwin-Duckworth 50-401A
Division of Chain Belt Company
363 Plainfield Street, Springfield, Mass.

Gentlemen:
Please send me my free copy of Bulletin 49-3 containing all the facts, prices and other data on Double Pitch Chains.

Name.....

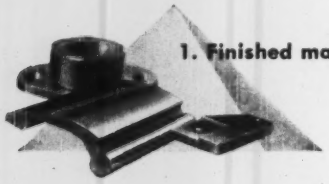
Firm.....

Address.....

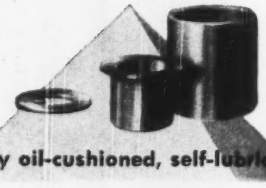
City.....State.....

Customers state... **Oilite**

Products *yield pyramidal savings...*



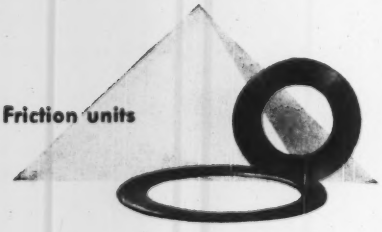
1. Finished machine parts



2. Heavy-duty oil-cushioned, self-lubricating bearings

3. Permanent filters

4. Heavy-duty oil-cushioned, self-lubricating cored and bar stock



5. Friction units

Contact your local Oilite field engineer or home office

SAVINGS in

- Unit Cost
- Assembly Cost
- Capital Investment
- Burden • Floor Space

PLUS

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PLUS

(Nationwide and Canada)

- Field Engineers
- Distributors • Dealers
- Bearing Depots

Amplex MANUFACTURING COMPANY

SUBSIDIARY OF CHRYSLER CORPORATION
DETROIT 31, MICHIGAN

LABOR COSTS ARE UP...
HANDLING COSTS

Rising "break-even" points make savings in your handling costs practically mandatory today. Why? Because in most industries *the greatest single item of labor costs is materials handling.*

G-W conveying systems can cut those costs in every phase of your manufacturing cycle. Necessary material handling can be *simplified.* Manual and unnecessary handling can be *eliminated.*

Often, installing one or two standard G-W conveying units will be enough to substantially reduce handling costs. Perhaps you need equipment designed to move materials upstairs, downstairs, through firewalls, around corners, through crossovers. G-W's *complete* materials handling *service* can solve your problem. Skilled engineers, with G-W's 135 years of experience behind them, will analyze your handling needs. They will design, construct, and install the conveyor or elevator equipment best suited to pare down your handling costs.

G-W furnishes *every* type of equipment — power, or gravity, — to move *every* kind of material, in *every* type of industry. Write today, sending specific details, and recommendations will be made — at no cost.

G-W HANDLES IT...FASTER • EASIER • CHEAPER...

GIFFORD-WOOD CO.

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SINCLAIR RESEARCH LABORATORIES, Harvey, Illinois. *Architects, Engineers and Contractors, The Austin Company.*

who said **inspiration** meant **perspiration?**

Not here it doesn't. Not in the Sinclair Refining Company's two new Research buildings. In the Laboratories building Carrier Duct-type Weathermasters are used to maintain a constant temperature and humidity despite highly variable heat loads, keep research equipment and research workers at peak efficiency. In the Administration building, on the other hand, Carrier Conduit Weathermasters permit the occupant of every office to dial his own weather.

Both systems are supplied by a Carrier Centrifugal Refrigerating Machine in the Laboratories building. Both systems give you: year-round air conditioning; heating and cooling combined in one system; centralized mechanical elements. That adds up to: health and comfort; savings on fuel and maintenance costs; simpler servicing; undivided responsibility. If you are considering a heating, refrigerating or air conditioning installation, call Carrier. Carrier Corporation, Syracuse, N. Y.

Carrier **AIR CONDITIONING • REFRIGERATION • INDUSTRIAL HEATING**

An imaginative automotive engineer used

Spongex® cellular rubber

to keep rattles and weather out for greater driving pleasure

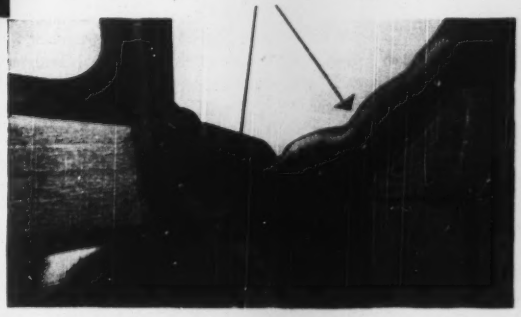
Suppose your car doors shut metal to metal! What a *crash* when you slammed them. What squeaks, rattles and groans as you drove along! And you'd get wet. You would freeze. It would *always* be drafty.

But a sponge rubber product seals out drafts, temperature and moisture . . . cushions shock and vibration . . . absorbs noise. Doors shut snugly and quietly, slam after slam after slam.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application. We welcome new problems.

Illustration below—The vertical cord is decorative and functional. This fabric covered Spongex cord seals out drafts.

On door and body are Spongex pieces molded around metal to afford reinforcement, rigidity and mechanical fastening.



Spongex forms shown are from molds designed by us and owned by our customers. As such they are not offered for sale. Similar products can be molded to your requirements in molds designed for you.

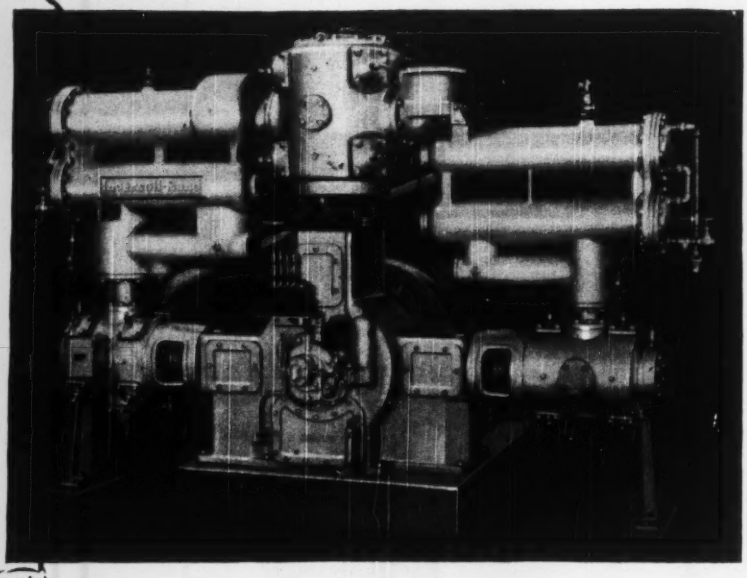
TECHNICAL BULLETIN ON SPONGE RUBBER AVAILABLE ON REQUEST

The World's Largest Specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

301 Derby Place, Shelton, Conn.

MASTER OF MANY TRADES



bearings engineered by SKF

Ingersoll-Rand's 3-stage TVH Heavy-duty Compressors are widely used for boiler soot-blowing service, for handling gases where leakage must be avoided, for compressing air in oxygen production, and in scores of other applications. They're compact, highly efficient, give long-life heavy-duty service. The two main bearings are SKF Double-Row Self-Aligning Spherical Roller Bearings. They require no adjustment . . . are engineered and built to withstand heavy radial and thrust loads. SKF specializes in supplying the bearing that's right for the job . . . the bearing that keeps friction at a minimum and makes important contributions to long-term trouble-free operation. SKF Engineers will work with you in helping you design for greater efficiency and lower operating costs. **SKF** INDUSTRIES, INC., PHILADELPHIA 32, PA., *the Pioneers of the Deep Groove Ball Bearing – Spherical Roller Bearing – Self-Aligning Ball Bearing.*

71A6

SKF

BALL AND ROLLER BEARINGS

8 REASONS WHY **SKF** IS PREFERRED BY ALL INDUSTRY

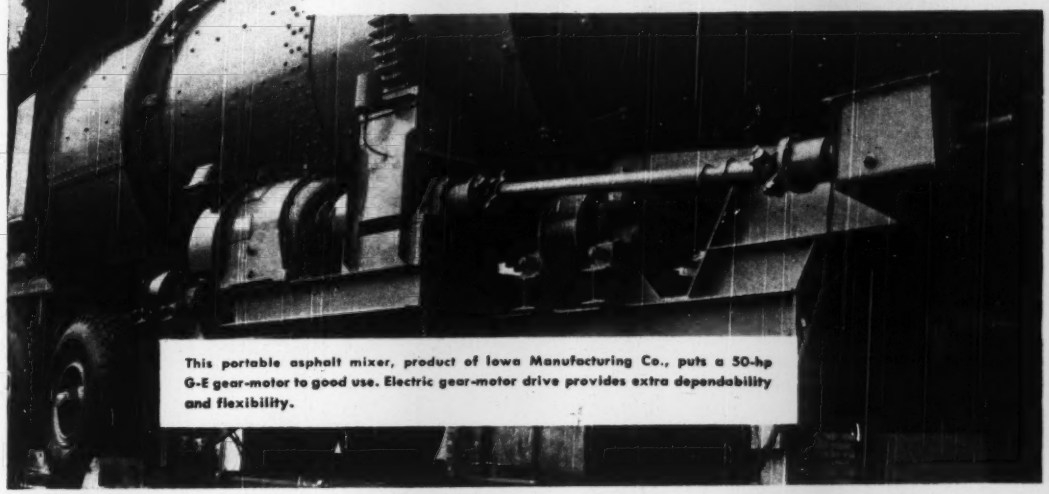
Integrity – Craftsmanship – Metallurgy – Tolerance Control

Surface Finish – Product Uniformity – Engineering Service – Field Service

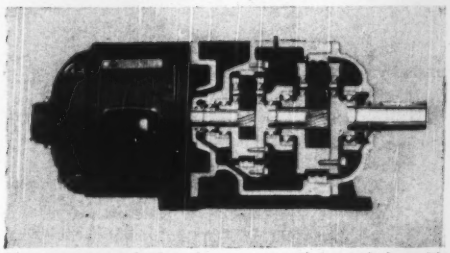
Yes! we said gear motors

UP TO 150 HP

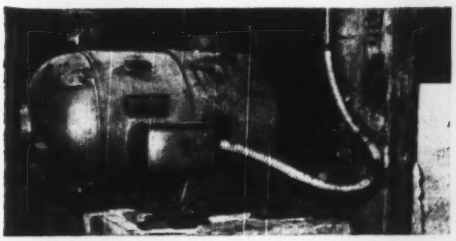
for dependable low-speed drive



This portable asphalt mixer, product of Iowa Manufacturing Co., puts a 50-hp G-E gear-motor to good use. Electric gear-motor drive provides extra dependability and flexibility.



Planetary gear reduction gives you smooth transmission with the greatest load-carrying capacity in the smallest space.



In another asphalt-processing operation, easy starting and smooth operation of this 60-hp Tri-Clad gear-motor are producing substantial savings. The gear-motor replaced a steam-engine drive.

G-E TRI CLAD GEAR-MOTORS

compact, efficient, extra-protected

Even for large low-speed drives up to 150 hp, there's a G-E gear-motor that can fill the bill. With it you eliminate separate gears or reducers, because you buy only one compact, pre-engineered power package. You save purchasing and engineering costs by specifying one unit to do the job.

In hazardous areas, too, G-E explosion-proof gear-motors offer extra protection for applications where open gears, belts, and pulleys are prohibited . . . and in addition to these features, you get:

UNIT RESPONSIBILITY— G.E. assumes unit responsibility for both gear and motor, whether it's rated at 1 or 150 hp. You avoid many design and purchasing problems.

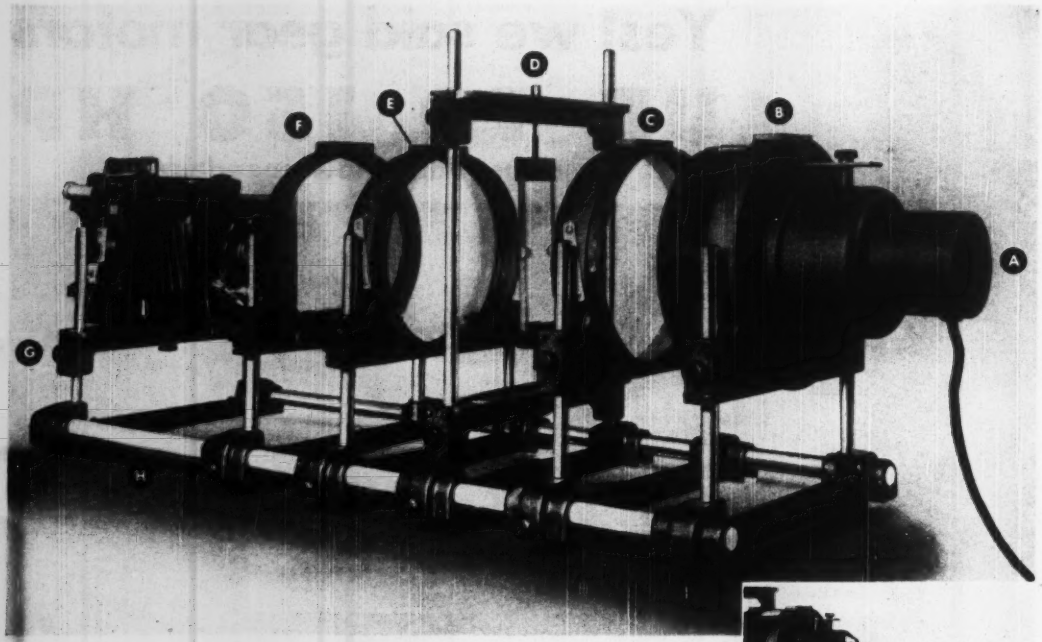
PRE-ENGINEERING— G-E gear-motors are pre-engineered to work as a unit, give you the best possible combination of gear and motor for your job.

OVER-ALL PROTECTION— Integrated housing shields the whole unit from dust and dirt, permits application where chains and belts cannot be used.

Standard ratings up to 75 hp are available from stock, and special quotations are issued for ratings up through 150 hp. To fill your needs on all gear-motor requirements, call your nearest G-E Sales Office or your local distributor. Apparatus Dept., General Electric Co., Schenectady 5, New York.

GENERAL ELECTRIC

155-5



A New, Low Cost, Portable POLARISCOPE for Dynamic Stress Analysis

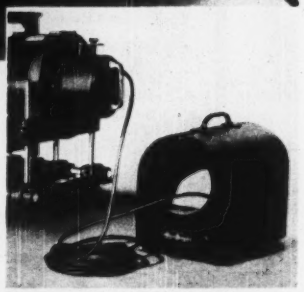
UNTIL now the apparatus required for either visual or photographic observation of photoelastic stress, either static or dynamic, has been cumbersome, expensive, excessively bulky and very heavy.

Through use of the G-R STROBOLUME as a very high-intensity light source for photography, all of these objections have been overcome. Formerly, photographic exposures ran into minutes; the bench set-up accordingly had to be carefully designed to minimize vibration in its many parts. The new G-R Polariscope consists of an assembly of comparatively light rods, supports and disc mounts, this lightness being possible through the extremely short 40-microsecond exposure provided by the STROBOLUME.

This new Polariscope includes in its many features:

- An unusually large field — 8 inches in diameter
- Very simple means for making instantaneous photographs of dynamic stresses . . . requires only a standard camera with an f/4.5 lens
- Time exposures no longer necessary . . . the STROBOLUME flashes in 40 microseconds
- The 40-microsecond flash stops motion for dynamic stress patterns
- Unusually short wave length light . . . very high sensitivity
- Complete portability . . . weighs only 32 pounds . . . quickly assembled and dissembled . . . ideal for lectures and other demonstrations
- Easily removed quarter plates and polarizers
- Simplified replacement of damaged elements . . . snap-in assembly
- Convenient to use . . . horizontal and vertical adjustments over wide ranges . . . simpler than an optical bench
- Very low cost

TYPE 1534-A POLARISCOPE . . . $490.00



The Type 1532-A STROBOLUME in place, with its power supply at the right. One knurled nut readily removes the STROBOLUME lamp for substitution of the standard incandescent lamp for visual observation. **Type 1532-A Strobolume,** complete and ready to use, **$225.00**

SPECIFICATIONS

- **A** Type 1534-P6 Incandescent Lamp Housing
- **B** Type 1534-P2 Diffuser
- **C** Type 1534-P1 Polarizer
- **D** Type 1534-P3 Strain Bridge for Sample
- **E** Type 1534-P1 Analyzer
- **F** Type 1534-P5 Filter
- **G** Type 1534-P4 Camera Bridge (Camera not supplied)
- **H** Type 1534-P7 Shafts (furnished 36-inches long)

Accessories Required for Photography

A G-R Type 1532-A STROBOLUME

Standard camera, preferably with ground glass focusing, with f/4.5 or faster lens

Wratten No. 75 front-of-lens filter, recommended to reduce effects of normal room lighting

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

First commercial ultrasonic testing of HT-HP power piping shows value of method!

For years power engineers have known that alloy power piping might on occasion contain defects which could not be discovered by inspection methods other than radiography. But rather than adopt the virtually prohibitive expense of radiographing complete lengths of pipe, designers specified relatively high safety factors.

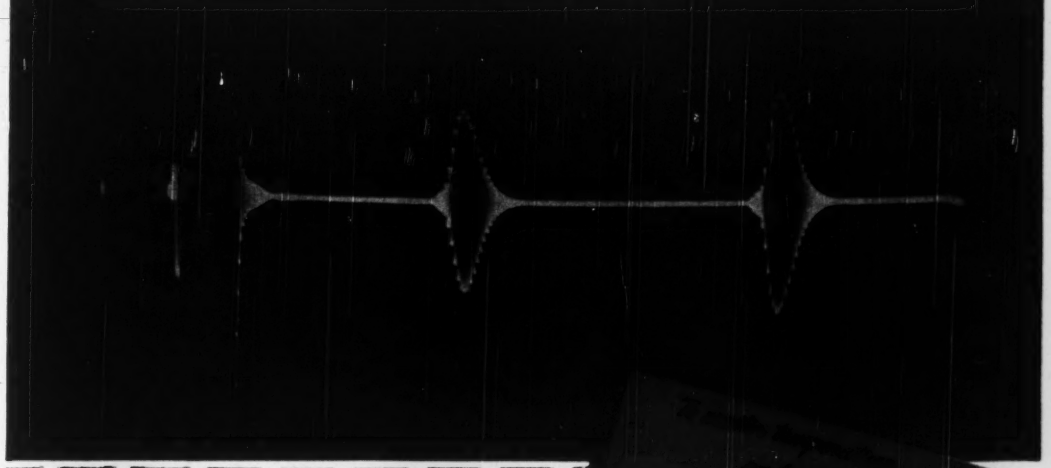
Of course this precaution did not preclude the possibility of defects, and when failures have occured, subsequent investigations have shown that internal cracks were usually the cause of the ruptures.

To meet this problem, investigations were made of inexpensive, non-destructive pipe inspection methods which could reveal hidden defects, and late in 1949, Kellogg, in cooperation with a large turbine manufacturer, presented a practical solution with the introduction of commercial ultrasonic testing of alloy piping.

Ultrasonic exploration of materials, although known for several years, has only recently been attempted on power piping. Indications now are that this technique will prove a successful and low cost means for discovering flaws and, furthermore, for putting a finger on them with startling accuracy. In view of the steadily increasing temperatures and pressures demanded by the economics of modern power generation, the value of this development is obvious.

Specific and continuing studies of this nature are among the many advantages that utility companies gain when they specify high-temperature and high-pressure piping fabricated by M. W. Kellogg.

Illustrated: Screen pattern on the 'scope of the portable ultrasonic testing equipment currently being used by Kellogg in both shops and field.



Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

M. W. KELLOGG

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

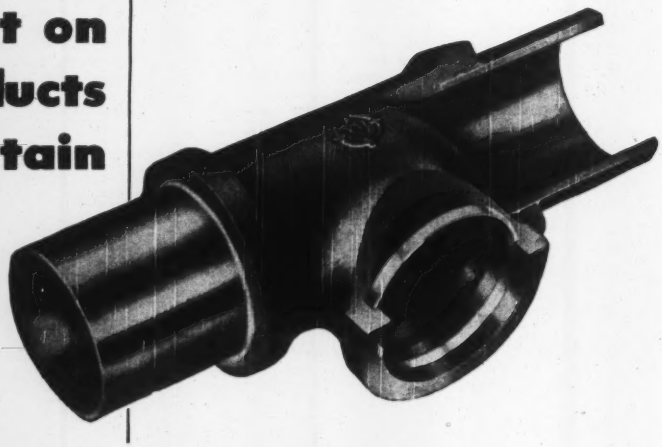
Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

★

The M. W. Kellogg Company (Subsidiary of Pullman, Incorporated)—Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

DON'T BE SATISFIED WITH HALF-WAY MEASURES...

insist on Walseal® products and be certain



– the FACTORY INSERTED Ring insures FULL PENETRATION of the Silver Alloy . . . a perfect joint

Today, contractors . . . builders . . . architects are using brazed connections, in ever increasing numbers on their brass and copper pipe runs. However, they must be certain that the correct brazing alloy is used; that the joint has penetration of alloy up the shoulder of the fitting.

That's why more and more are turning to Silbraz® joints made with Walseal valves, fittings and flanges which assure the proper amount of alloy with no waste. They know that the finished joint not only will withstand hydrostatic pressure, but it will also withstand terrific impact and vibration – in fact, no correctly made Silbraz joint has ever been known to creep or pull apart under any pressure, shock, vibration or temperature which the pipe itself can withstand.

Furthermore, it is a relatively simple operation to make a Silbraz joint – no heavy scaffolding need be erected . . . just cut the pipe, flux, assemble, then braze, following the technique recommended by the Walworth Company. A silver brazing alloy – FACTORY INSERTED – in each port flows out when heated with the oxyacetylene torch, making a joint that is stronger than the pipe itself . . . a one-hand operation, with the mechanic out of the path of the deflected heat – at all times.

For full information about Silbraz joints made with Walseal products, write for Circular A-1.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Dollar and Cents Angle

on Fafnir Sealed Ball Bearings

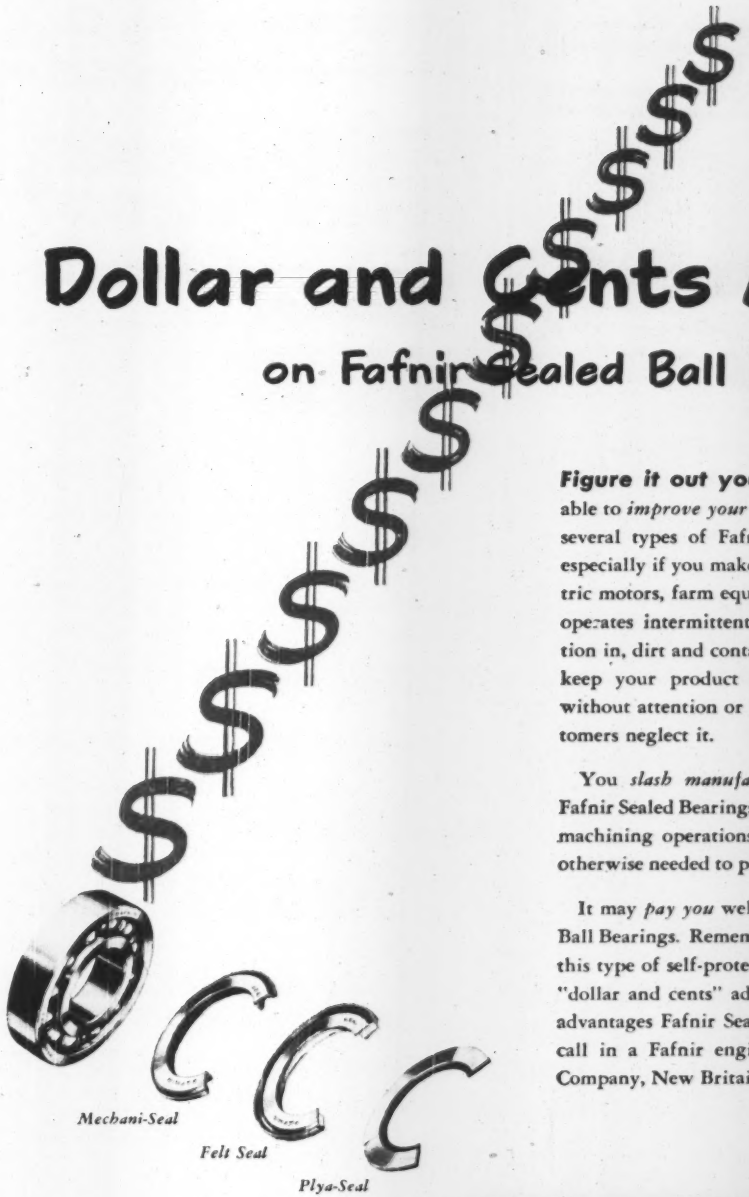


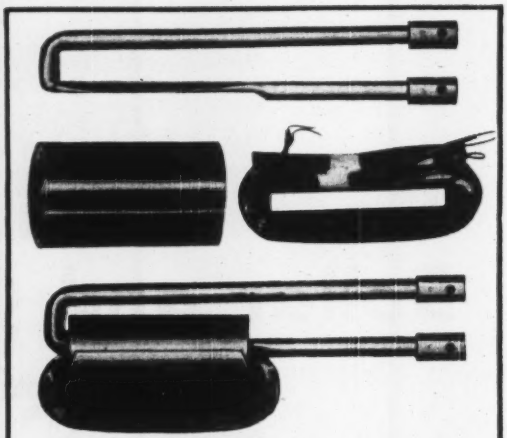
Figure it out yourself . . . You may be able to *improve your product* by using one of the several types of Fafnir Sealed Ball Bearings — especially if you make household appliances, electric motors, farm equipment . . . anything which operates intermittently. Sealed to keep lubrication in, dirt and contaminants out, these bearings keep your product running smoother, longer, without attention or breakdowns even when customers neglect it.

You *slash manufacturing costs,* too, because Fafnir Sealed Bearings simplify assemblies, cut out machining operations, and eliminate extra parts otherwise needed to provide and retain lubricants.

It may *pay you* well to switch to Fafnir Sealed Ball Bearings. Remember, only ball bearings offer this type of self-protection which results in these "dollar and cents" advantages. To find out what advantages Fafnir Sealed Bearings can offer you, call in a Fafnir engineer. The Fafnir Bearing Company, New Britain, Conn.

MOST COMPLETE LINE IN AMERICA

HEAVY, LESS EFFICIENT and slower to assemble, was the original Weller Soldering Gun composed of the parts shown. Compare these with the fewer parts at right in the new Gun, and you'll readily see why the new streamlined Weller is so popular.



THE NEW WELLER SOLDERING GUN handles 250 watts; heats, ready for use, in five seconds; has longer range to get into the tight spots, and is equipped with spot light. Uses current only when trigger is operated. It is assembled faster. Requires no bolts or nuts. The ⅜" Revere Copper Rod that replaces the secondary coil in the transformer is sheared, flattened, and bent at right angles in a 200-ton press in a single operation.

COPPER TREATS YOUR PRODUCT BETTER WHEN YOU

Control Your Temper

Revere Copper Rod replaces Secondary Coil in Soldering Gun Transformer . . . reduces number of parts, makes for a speedier, more efficient assembly . . . also makes possible a lighter, more compact unit of increased capacity.

WHEN the Weller Manufacturing Company, Easton, Pa., was completing the development of its new electric soldering gun, they were confronted with this problem: The ⅜" Revere Copper Rod used to replace the secondary coil in the transformer had to maintain its rigidity yet be sufficiently soft so that during the shearing, coining, and bending operations there would be no breaking or splitting of the rod.

Revere's Technical Advisory Service recommended a certain temper copper rod. It was discovered that Weller was getting a twist in the rod when it was installed in the assembled gun. Other tempers were tried and tested. Then a copper rod of a slightly harder temper than the first was recommended. That was it! Proper temper was the key. Proper temper was also the key to the .291 dia. copper rod used for the Soldering tip itself. For this, too, had to retain its rigidity and yet remain soft enough to be coined, punched, and formed without fracture.

"In addition to being extremely helpful in arriving at the proper tempers, Revere also recommended that we specify our rod in multiple lengths, and thus save considerably on scrap. They were also helpful in solving the problem of attaching the brass sleeve to the secondary rod in our Soldering Gun," the Weller Manufacturing Company tells us.

So you see, Revere's interest in your problem does not stop with the recommendation of its products. Perhaps Revere can help you. Why not take your current problem to the nearest Revere Sales Office and see?

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

* * *

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

You Save on 4 Counts with ENCO STREAMLINED BAFFLES

1 Better heat transfer

Enco's improved baffle design insures a uniform, high velocity gas flow over every square foot of heating surface.

2 Low draft loss

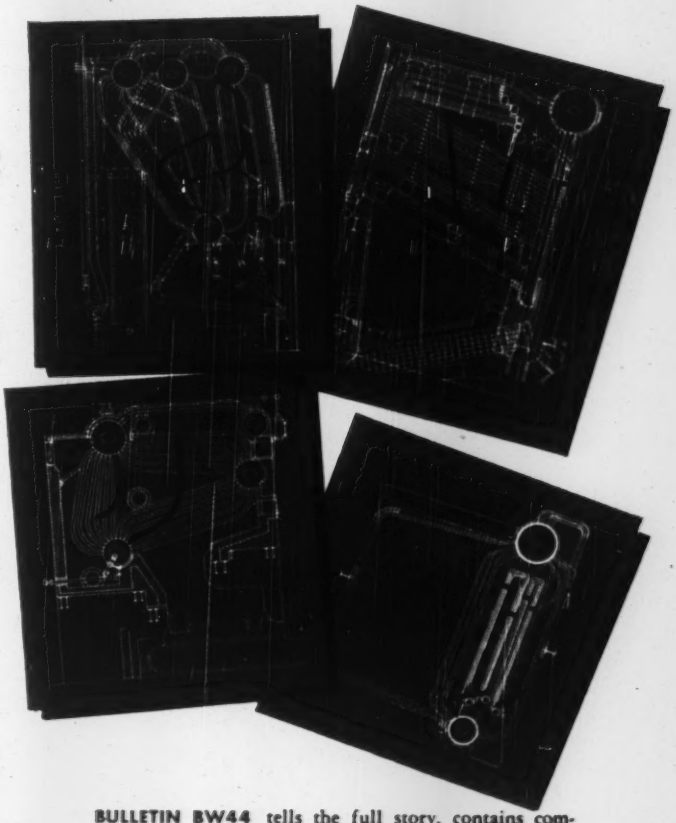
Smoothly curved baffles maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and eddy currents are eliminated.

3 Less steam, less time for cleaning

Soot doesn't get a chance to accumulate in pockets. Soot blowers are used less often. Streamlined baffles lower maintenance costs.

4 Custom installation

Experienced Enco crews take charge of the installation, repairs and replacements of your individually designed streamlined baffles—do the job thoroughly and quickly with minimum downtime.



BULLETIN BW44 tells the full story, contains complete engineering data, explains how Enco Baffles provide maximum steam output with minimum fuel consumption. WRITE FOR YOUR FREE COPY TODAY!

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

How

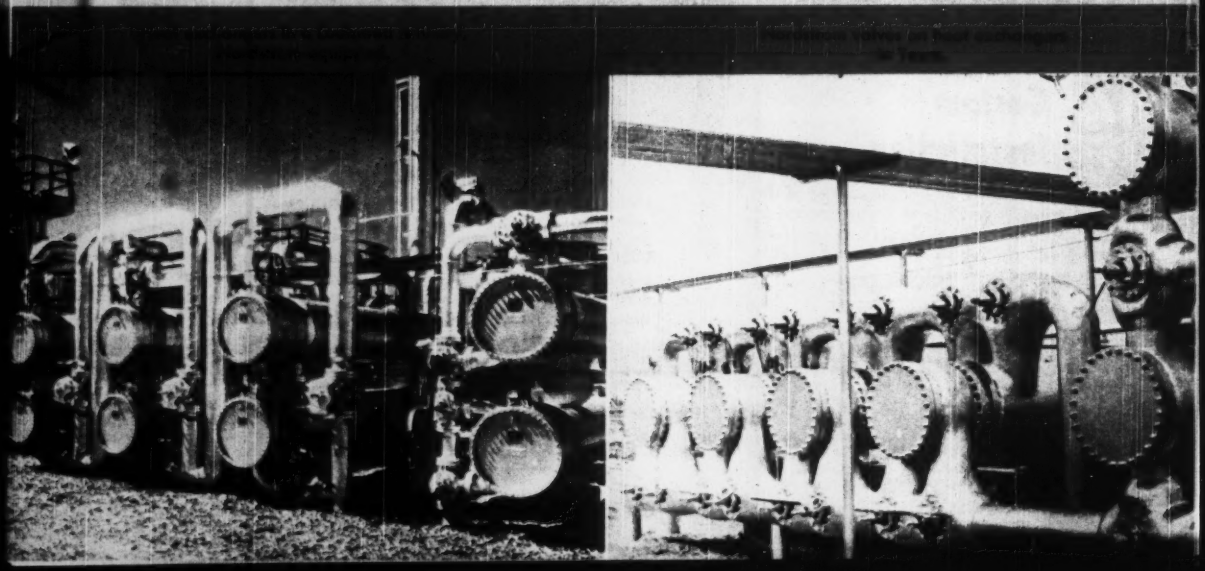
HANGER UNITS

can be more safely serviced

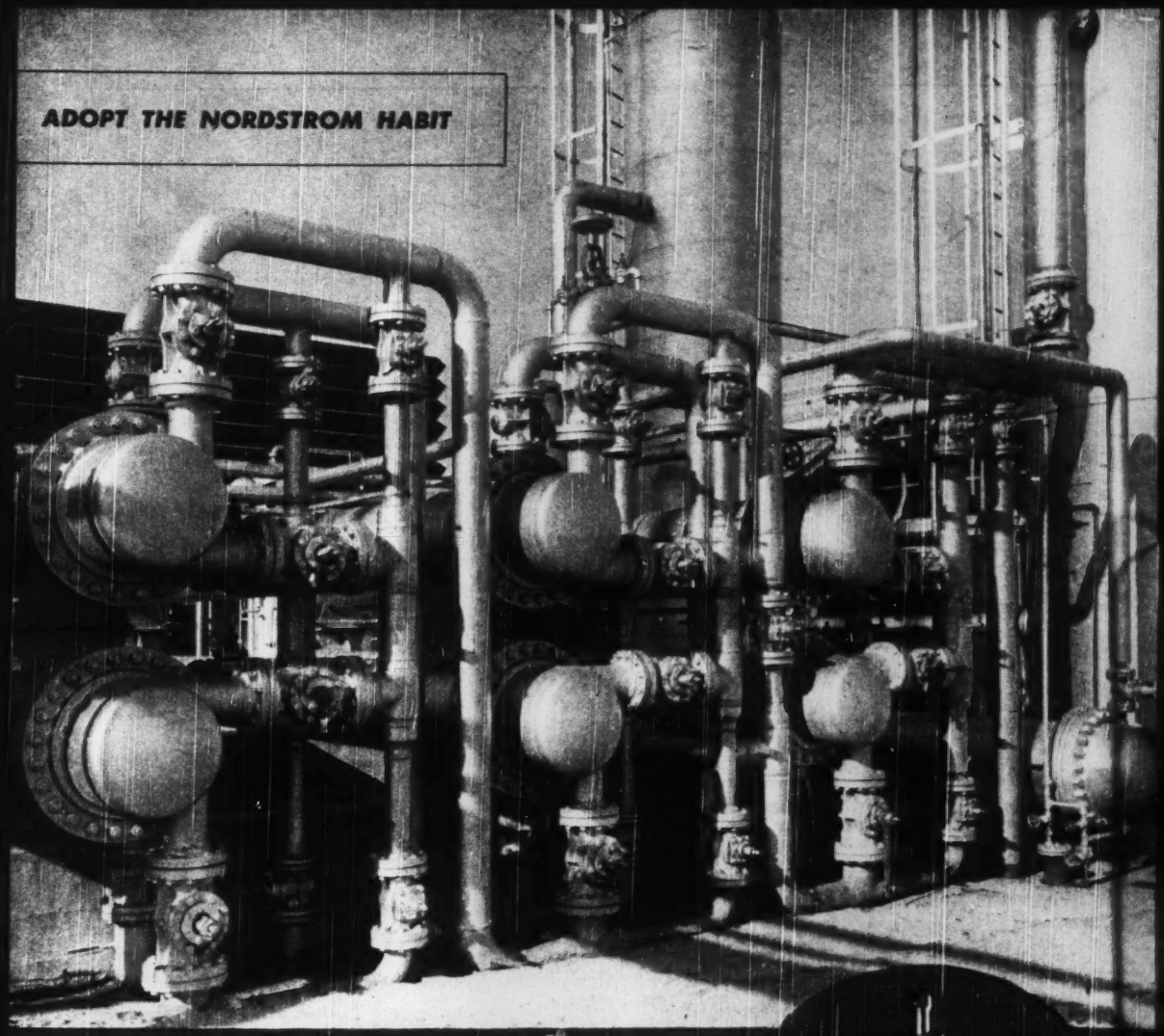
Heat exchanger batteries are usually in continuous operation with piping arranged so that individual units may be taken out of service for maintenance without interrupting flow through the other units. The success of this operation is dependent on reliable and effective switching valves. If equipped with conventional valves which are vulnerable to leakage or failure, unit maintenance becomes difficult and hazardous or the entire battery may have to be shut down. But, if equipped with Nordstrom valves, individual units can be serviced readily because there's *no leakage, no hazard, no valve failure.* Uninterrupted plant operation, with Nordstroms, can easily save far more than the cost of the valves.

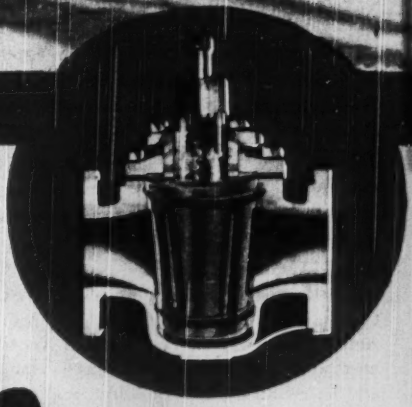
Adopt this habit...

Each time a troublesome heat exchanger valve demands replacement—change to a Nordstrom. Eventually the entire battery will be Nordstrom-equipped. The cost? No more than ordinary valves when you figure the improved service and greatly increased valve life.



ADOPT THE NORDSTROM HABIT





Nordstrom

LUBRICATED Valves

NOW AUTOMATICALLY LUBRICATED WITH

PATENTS APPLIED FOR

Hypermatic

TRADE MARK

ROCKWELL MANUFACTURING CO.

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Export — Rockwell Mfg. Co., International Division, Empire State Building, New York 1

American Blower—a time-honored name in air handling

In Detroit, as in other cities, American Blower Air Handling Products serve commerce, industry and public utilities. For air handling data in Detroit, call American Blower—TRinity 2-4300. In other cities, consult your phone book.

Look before you buy. There's a big difference in quality, design, quietness, operating costs and efficiency between American Blower and other air handling equipment. Comparison tests prove the superiority of American Blower products.

Air is free . . . use it profitably!

THE buyer of an American Blower Kitchen Fan . . .

The public utility which orders American Blower Mechanical Draft Fans, Gyrol Fluid Drives or Fly Ash Precipitators . . .

The cement plant which installs American Blower Air Handling Equipment . . .

All these buyers get one thing in common.

They get equipment which is built by a manufacturer with a background of 69 years' experience—equipment which is tested in accordance with the Standard Test Code as adopted jointly by the N.A.F.M. and the American Society of Heating and Ventilating Engineers and carries Certified Ratings—equipment which is the result of the broadest and most thorough methods of engineering and research known.

These plus values are further assurance to you of lower operating costs and long, dependable service.

For data, ask your Heating, Ventilating or Air Conditioning Contractor or our nearest Branch Office.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

YOUR BEST BUY

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AIR HANDLING EQUIPMENT

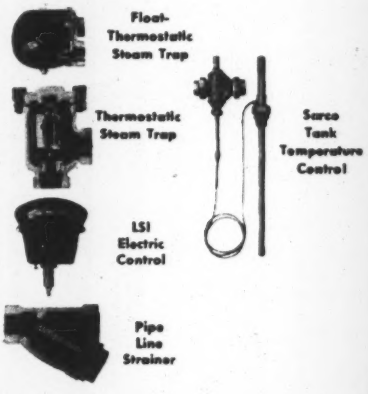
Serving home and industry

AMERICAN STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

TOP QUALITY *and* QUANTITY PRODUCTION

for this Sarco Controlled Drying Operation

SARCO PRODUCTS FOR FOODS AND CHEMICALS



Thousands of dollars worth of hides pass through drying chambers every day, in this New England Tannery plant. Who can watch the thermometers and run around turning valves fast enough to prevent the hides from "burning"? Who knows whether the equipment has been run at top capacity with a minimum of precious fuel used?

No human being can claim perfection on a job like this — but Sarco can, and proves it every day on a score of different kinds of drying operations in a dozen industries.

In the plant illustrated, the inexpensive Sarco LSI increased production with the same equipment and operators — and without losing hides due to incorrect drying temperatures.

IN YOUR PLANT it may be a temperature control on hot water or a few dollars spent for individual traps on every steam coil that will boost production with less fuel, and insure a better, more uniform output. A few of the Sarco Products that do just that are shown at the left. Send us a sketch of your heating processes or ask to have the Sarco man near you look over your plant.

309

SARCO SAVES STEAM

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Represented in Principal Cities
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IMPROVES PRODUCT QUALITY AND OUTPUT

Clips, clamps, retainers, rings–
all sorts of springs....
B
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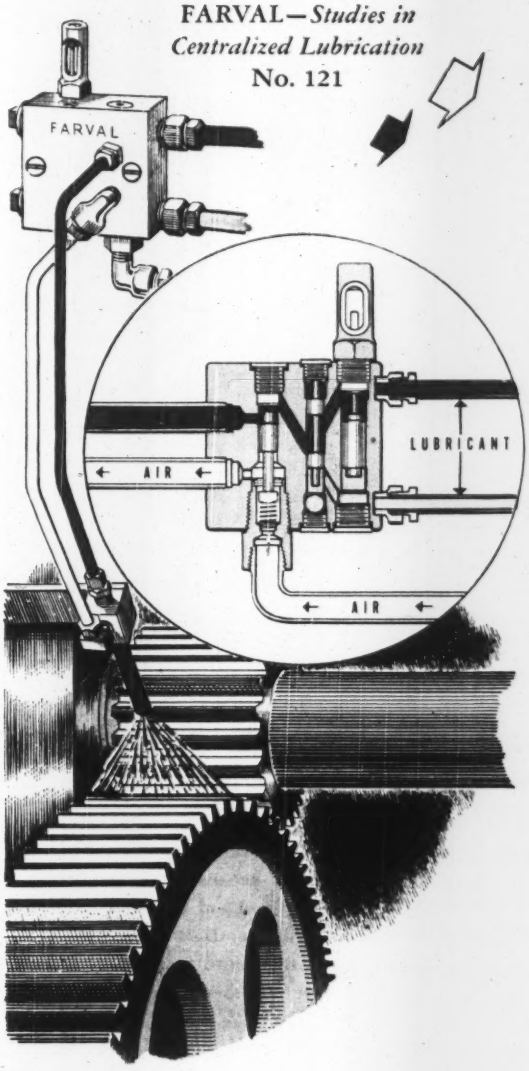
R
B-G-R makes those off-the-beaten-path special springs that find so many uses in thousands of mechanical products. Let's see a sketch or blueprint for quotation or solution.
BGR
Springs
Wire Forms
Small Stampings
BARNES · GIBSON · RAYMOND
DIVISION OF ASSOCIATED SPRING CORPORATION
Two Plants for Spring Service
DETROIT 11, MICHIGAN
ANN ARBOR, MICHIGAN

FARVAL—*Studies in Centralized Lubrication* No. 121



New Farval Spray Valve

meters lubricants to slide surfaces and open gearing

CONTROLLED spraying of lubricant on open gearing, slide surfaces, etc., is practical with the new Farval Spray Valve.

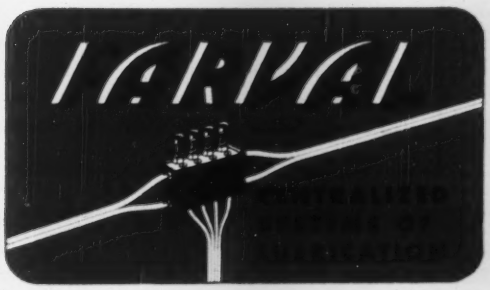
By an ingenious adaptation of the familiar Farval Dualine Valve, either grease or oil is sprayed through a nozzle—on any desired area, in any desired amount, and at any desired interval. The new spray valve can be added at any point in a regular Farval Dualine System where compressed air is available—or a complete system may consist entirely of spray valves, served by either manual or automatic pumping unit.

Compressed air from the supply line is directed through the spray valve, which meters air to the delivery nozzle just as lubricant is metered. By a unique arrangement, the lubricant valve also turns on and shuts off the air. Thus the quantity of air used is limited to the amount needed to spray each delivery of oil or grease, without exhausting or reducing pressure. Positive cut-off of lubricant by the Farval valve after each delivery eliminates bleeding from the nozzle—no waste, no mess, no trouble.

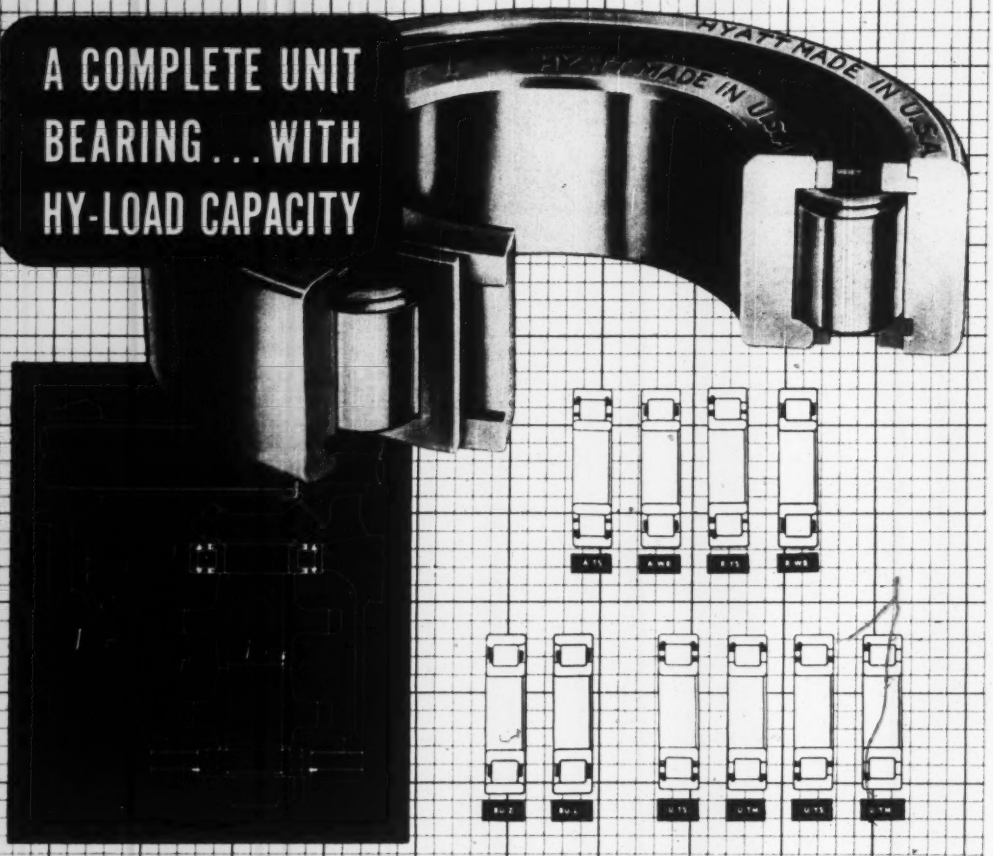
The Farval Spray Valve has been thoroughly tested in service and is now in use on a wide variety of machines and equipment. It has demonstrated its ability to supply lubricant efficiently and economically to open gearing, slide surfaces, in fact, wherever a standard Farval Dualine closed system is not readily adaptable.

Write for a copy of Farval Spray Valve Bulletin No. 60 for a full description, with illustrative diagrams and installation data. The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



A COMPLETE UNIT BEARING . . . WITH HY-LOAD CAPACITY



HERE is a cutaway illustration and typical application of the "U-TS" type Hyatt Hy-Load straight cylindrical bearing which has rollers, separator and races assembled into a single non-separable unit. The inner race has flanges and the outer race is grooved at both ends to accommodate retainment rings. The rollers are separated and spaced by a one-piece separator.

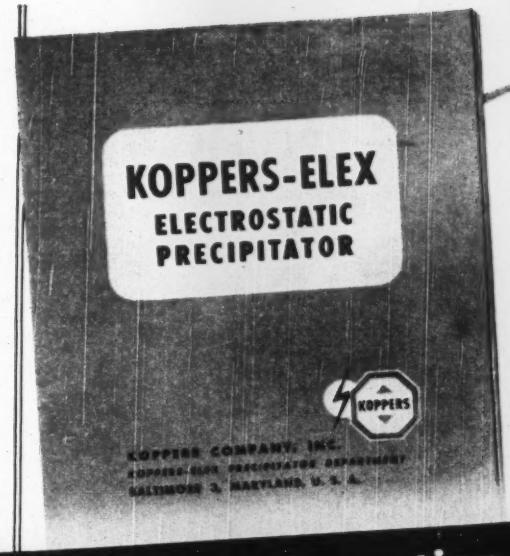
The "U-TS" type bearing is often employed in applications where no shoulder or stop is provided to retain the outer race in an axial direction or where the bearing must be assembled as a unit.

Separable inner race, separable outer race and complete unit Hy-Load Bearings are available with varying combinations of retainment rings and flanges to fit a wide range of application requirements.

• • •

Full information about all Hyatt Hy-Load Roller Bearings is contained in Catalog 547 . . . a complete engineering guide to radial bearing selection and use. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



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Booklet Describes How...

One factory specified 97% efficiency, but actually gets over 99% efficiency!

Gives vital information on how to make recovery, gas cleaning and nuisance abatement pay off!

Improved power units save money on installation cost.

•

Sequential rapping provides uniform stock discharge.

•

Insulators, protected from gas stream, require minimum maintenance and replacement!

•

High efficiencies are obtained around-the-clock for a full 24 hours a day!

•

New engineering on certain industrial gas applications enables recovery to pay up to 75% annual dividend on original cost!

•

Koppers-Elex provides for lowest possible pressure loss.

•

You can get both specified efficiency and residual content left in gas unconditionally guaranteed!

● No matter if your plant now uses precipitators, or plans to install one in the future—send for this timely folder! It's packed with performance and engineering data. Gives facts on maximum efficiency, shows how recovery, nuisance abatement or gas cleaning can PAY OFF!

Your copy contains illustrations, design information, facts about proper rapping, collecting and maintenance—all vital information collected by the Koppers Company in more than 60 years' manufacture of high-efficiency gas cleaning equipment.

To get your free copy, just fill out and mail the coupon below. There is no obligation. Check which field interests you most and mail coupon to the Koppers Co., Inc., Koppers-Elex Precipitator Dept., 220 Scott St., Baltimore 3, Maryland. We have only 1000 copies on hand, so to make sure you get yours—please mail the coupon today.

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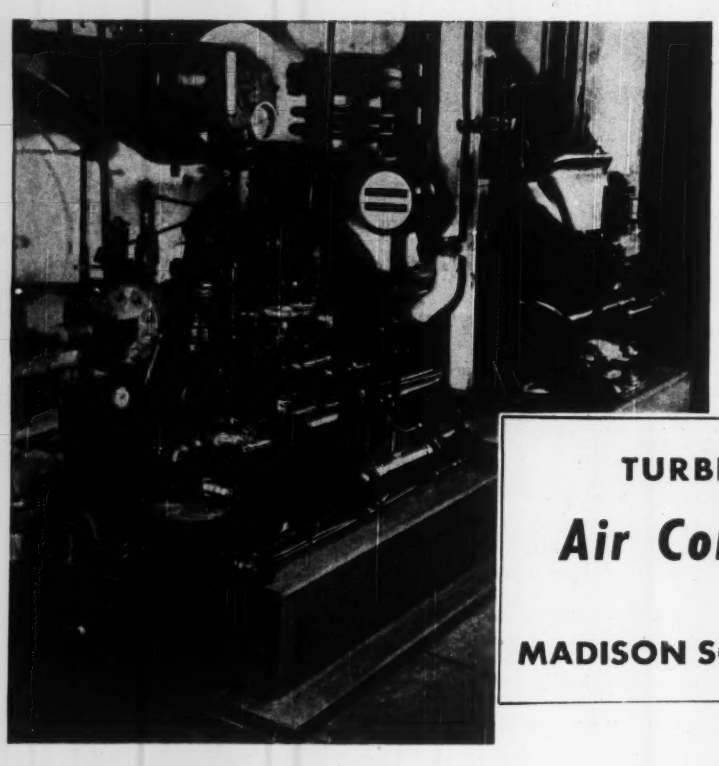
The TERRY TURBINE



TURBINES FOR

Air Conditioning

AT

MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

THE TERRY STEAM TURBINE COMPANY

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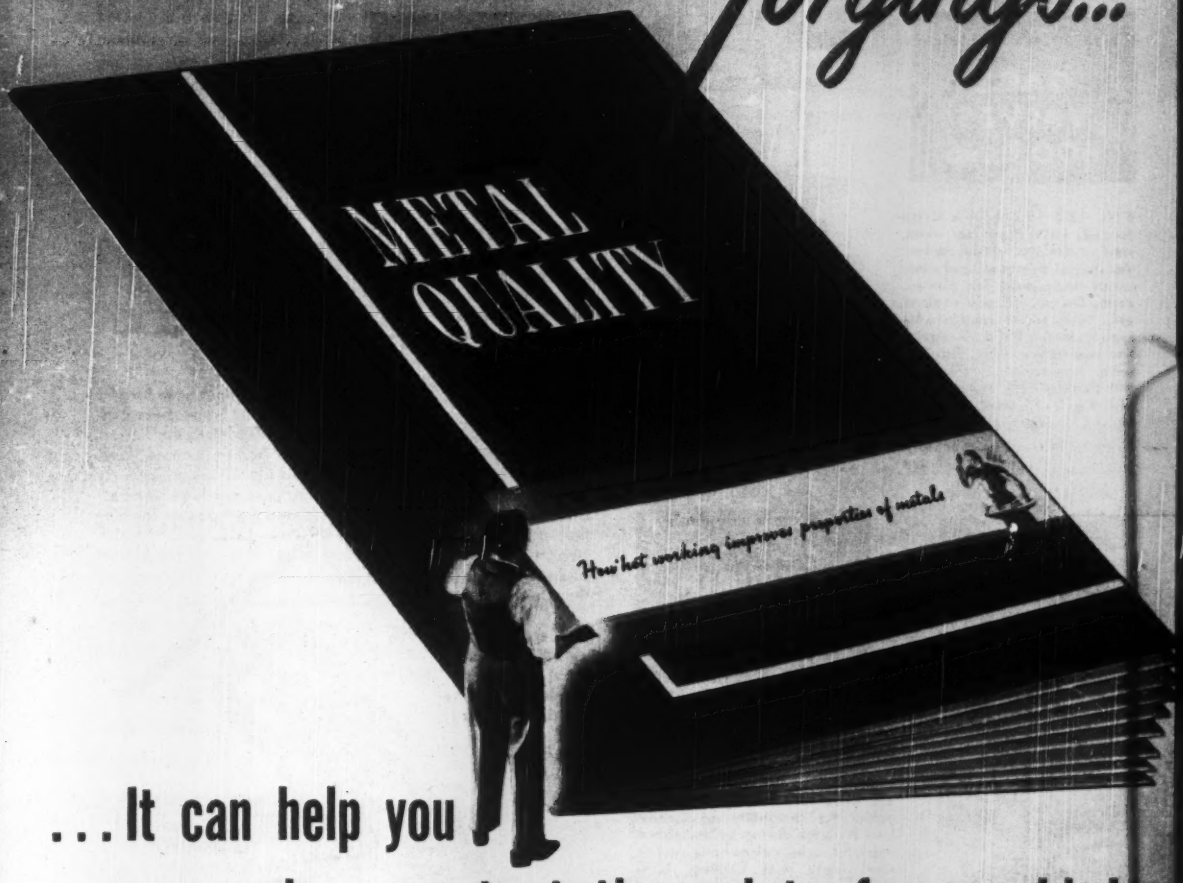

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GAGE VALVES 600 lb sp

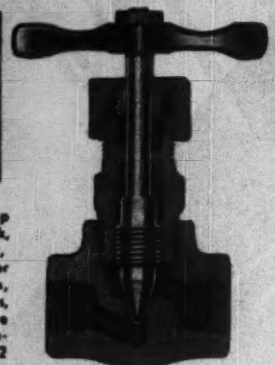


Fig. 152

FIG. 152 SERIES—A drop forged, instead of bar stock, steel valve for gage, meter, dead-end, instrument and other small lines, and for pumps, vents, Diesel and gas engines, etc. Long taper semi-needle type stem-disk for close regulation and tight seating. Fig. 152 series has carbon steel body with EValloy 13% chrome stem-disk. Fig. 2152 series, all 13% chromium stainless steel. Fig. 4152 series, all 18-8 stainless steel.

Screwed Ends—Globe or Angle

Size Range—⅛", ¼", ⅜", ½", ¾" and 1"

INSTRUMENT VALVES 1500 lb sp

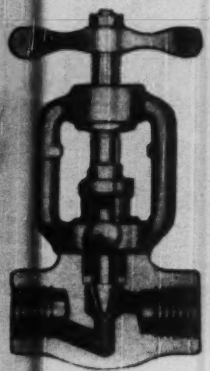


Fig. 952

FIG. 952 SERIES—A compact, heavy-duty valve for instrument panels, regulators, orifice meters, by-pass lines, oil field gage or instrument services, eprrosive lines, etc. Drop forged steel body and yoke. No possibility of bonnet joint leakage. Swing bolted gland. Fig. 952 series valves have carbon steel body with EValloy 13% chromium stainless steel trim. Fig. 2952 series has EValloy stainless steel body and trim.

Screwed or Socket Welding Ends—O. S. & Y.—Globe or Angle

Size Range—¼", ⅜", ½"

Globe & Angle Valves 600-1500 lb sp

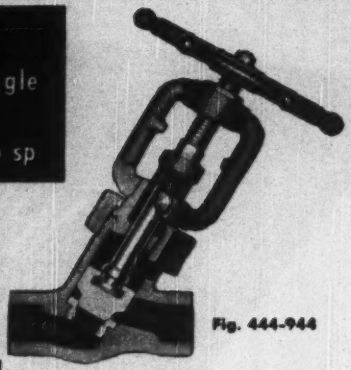


Fig. 444-944

FIG. 444-944 SERIES—All purpose valves, ideal for nearly any service where O. S. & Y. small forged steel valves are used. Streamlined, low-pressure loss body and bonnet both forged steel. Built with union bonnet in sizes 1" and smaller for 600 lb sp, and in sizes ¾" and smaller for 1500 lb sp. Larger sizes in both pressure classes have bolted bonnet joint. Bronze bushed yoke, simplified bolted gland design for easy packing adjustment, EValpak high pressure-high temperature die-molded packing, and inclined stem design for free flow and minimized turbulence are standard features. Easy to repack, with both hands free to insert packing. Stem, disk and seat hardened EValloy 13% chromium stainless steel regularly furnished; Stellite hard-faced seat and disk available on order.

Fig. 448-948

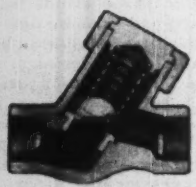
Screwed or Socket Welding Ends—O. S. & Y. —Globe or Angle

Size Range—⅛", ¼", ½", ¾", 1", 1¼", 1½" and 2"

CHECK VALVES 600-1500 lb sp

WIDE CHOICE

Edward forged steel check valves are built in ball or piston types, with union or bolted bonnets, with screwed, socket welding or flanged ends. Available for installation in either horizontal or vertical lines.

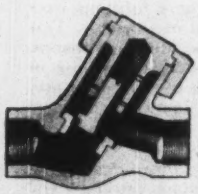


BALL CHECKS

Ideal for viscous fluid service. Spring loaded, fully guided ball disk is stainless steel, as is the mated seat.

Screwed or Socket Welding Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".

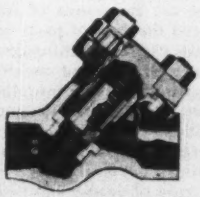


PISTON CHECKS

General service small check valves that give freedom from shock or excessive vibration, yet seat quickly and tightly upon flow reversal.

Screwed, Socket Welding or Flanged Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".



BOLTED COVER CHECKS

Either ball or piston types, in variations of body style and end connections for boiler feedline or general process services.

Screwed, Socket Welding or Flanged Ends—Horizontal, Vertical or Angle.

Size Range—½", ¾", 1", 1¼", 1½" and 2".

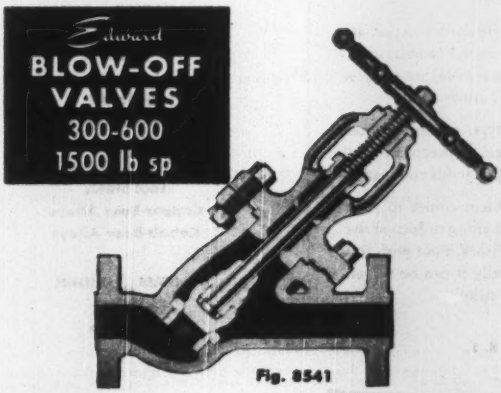
From New Edward Designs

These are among the many new Edward designs. The Edward steel valve line is never static. From a development department devoting its time exclusively to the problems of temperature, pressure and other operating conditions usually associated with the use of steel valves, have come—through the years—literally hundreds of design and material innovations. Many Edward features have become industry standards; others are still exclusive with Edward. The new designs described briefly here are ideally suited for the service conditions of today's power plant, petroleum, industrial and technological installations.

FIG. 2224 SERIES—Welded bonnet, inclined stem forged steel globe valves. Integral Stellited seat and disk construction, perfect alignment between body and bonnet, contoured for least resistance to flow and to cut wear-producing erosion. Bonnet joint leakage forever eliminated. Forged chromium-molybdenum bodies. Impactor handle available on larger sizes. Fig. 2224 series for 1500 lb service; Fig. 3924 for 2500 lb sp.

Socket Welding Ends—Globe Type

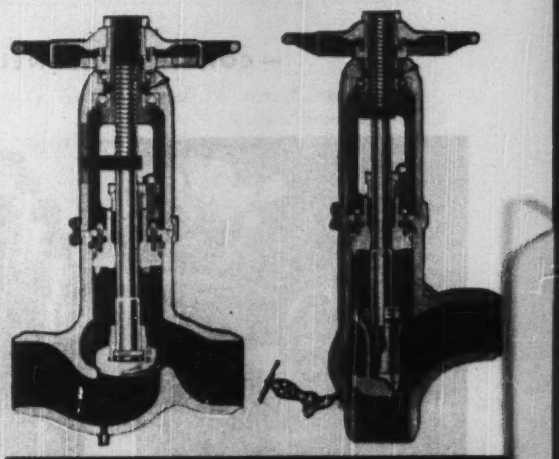
Size Range—½", ¾", 1¼", 1½" and 2"



FULL RANGE—Edward cast and forged steel blow-off valves, in straightway or angle patterns, meet all standards for blow-off valve service, and give complete flexibility in working piping hook-ups for any space limitation. Slow-opening type so that damaging shock to piping is eliminated.

Flanged or Socket Welding Ends — Straightway or Angle

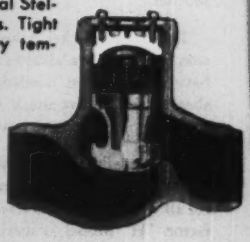
Size Range—1½", 2" and 2½".



Cast Steel Pressure-Seal Valves

900-1500-2500 lb sp

GLOBE AND ANGLE STOP, NON-RETURNS, CHECKS—Newest design pressure-seal bonnet valves in globe or angle stop or non-return and horizontal or angle check valves. Many features are Edward "firsts"—Impactor handwheels, EValthrust yoke bushings, Equalizers, streamlined flow passages, etc. Regularly built with integral Stellited seats and Stellited disks. Tight bonnet-joint connection at any temperature, low maintenance, easy disassembly, proven materials for top temperatures and reduced weight are among the features. All types in either 900, 1500 or 2500 lb sp classes.



Size Range—2½, 3", 4", 6", 8", 10", 12" and 14".

For more data on these or other valves in the complete Edward steel valve line, write for Catalog 104. Or, if you indicate special interests in valves or various types, we can include special bulletins you will find helpful.

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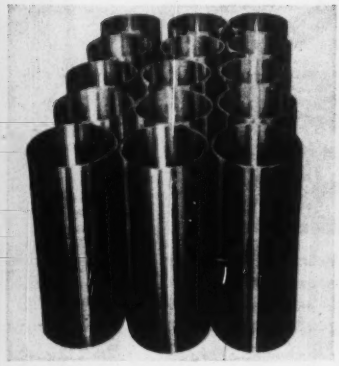
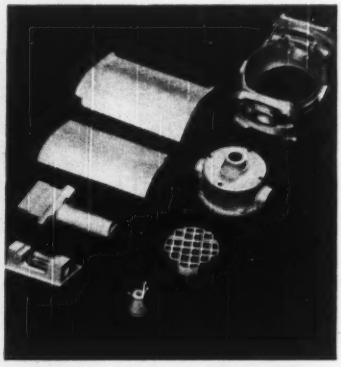


CENTRIFUGAL CASTINGS



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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 10

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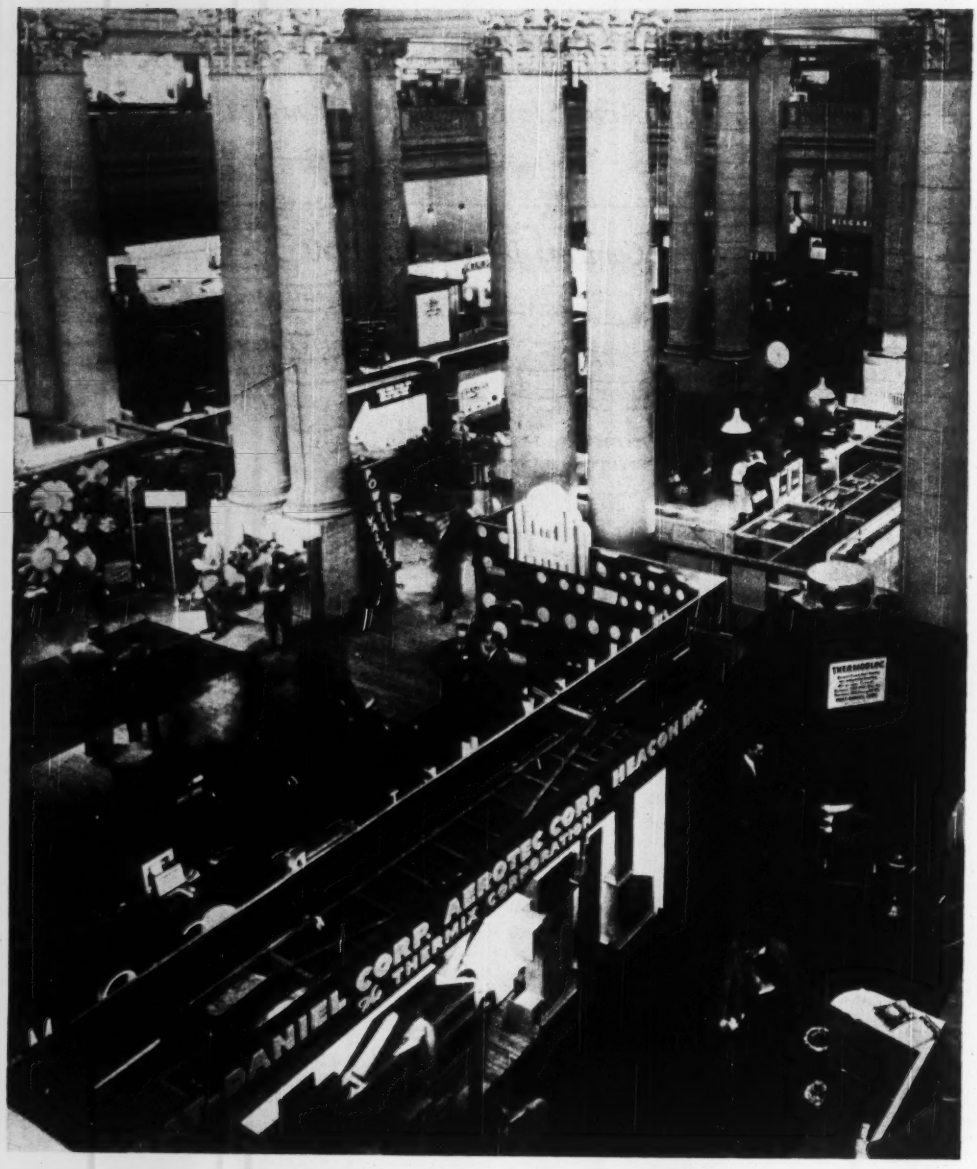

Grand Central Palace to Be Scene of Power Show

(*The Nineteenth National Power Show to be held in conjunction with the 1950 ASME Annual Meeting, New York, Nov. 27–Dec. 2, 1950.* *See page 837 of this issue.*)

VOLUME 72
No. 10

MECHANICAL ENGINEERING

OCTOBER
1950

GEORGE A. STETSON, *Editor*

EJC Achievement

IN OUR issue of May, 1950, we presented two parallel articles, "What Is ECPD?" and "What Is EJC?" The purpose was to present to engineers, and particularly members of ASME, a brief summary of the purpose, scope, organization, and principal achievements of two bodies which are supported by engineers and are working on their behalf and in the service of the engineering profession and the public. These bodies do not work for the direct personal benefit of the individual engineer. They are not primarily or directly concerned with the advancement of technical knowledge in the fields of science and engineering which is the engineer's special province and by means of which he becomes a useful and productive citizen and earns his living, although indirectly and in a larger sense this too comes within their scope and function. They are not bodies in which engineers hold individual membership, since membership in them is held by engineering societies or the appointed representatives of such societies. In fact, the individual engineer, who is normally deeply engrossed in immediate and personal affairs, who is asked to serve on no committee, who receives no regular publication or house organ, who votes for no officers and holds no office, who is presented no bill for dues for membership in ECPD or EJC, is likely to be only vaguely familiar with these bodies and their achievements. Hence both of these bodies are not only keenly conscious of the need of keeping engineers fully informed about their achievements; they also are under a heavy moral obligation to do so. In this connection, completion in September of a Survey of Selected Engineering Personnel, which was a joint project of the Office of Naval Research and Engineers Joint Council, affords an opportunity not only to publicize the event but also to offer it as convincing evidence of a valuable service of which engineers can be proud.

Certainly the events of the last few decades have demonstrated the importance of engineering in the security of the nation too convincingly to need emphasis here. Indeed, this importance is so generally recognized that the desire of the Department of Defense for a register of names of American engineers and records of their experience can be readily understood, just as the preparation of such a register will be hailed universally as an act of prudence and foresight, particularly in the light of contemporary events. Vast and well-manned with experts as our Military Establishment may be, there are frequent occasions, even in times of peace, when key personnel must be recruited and the services of specialists are required. In times of great national urgency the availability of such a register assumes crucial importance as it insures prompt selection of the best man to do a job.

A few years ago, when the Department of Defense decided that a register of selected engineering personnel was needed, there was before the Congress a bill to establish a National Research Foundation, one of the functions of which was to maintain a register of scientific and engineering personnel. Until this bill was enacted into law, as eventually it was last May, the Department of Defense decided that it must set up its own register. To the Office of Naval Research was delegated the administration of a survey to accomplish this purpose with funds provided by that Office. The fact that ONR turned to the engineering societies with the suggestion that Engineers Joint Council undertake the proposed survey was evidence that EJC had established itself as an organization known to be willing and competent to engage in such a venture. What resulted was a demonstration of the effectiveness of the EJC organization and of the manner in which such tasks are undertaken by it. After preliminary discussions an official request was addressed to EJC. Through EJC's National Engineers Committee a special Committee on Survey of Selected Engineering Personnel was appointed to deal with the proposal and administer the project. Because EJC is not an incorporated body it was necessary for one of its constituent societies, in this case The American Society of Mechanical Engineers, as agent for EJC, to enter into a contract with ONR to carry on the Survey. At the request of EJC and with the approval of the ASME Council the contract was drafted and signed.

With the signing of the contract a director, R. A. Wentworth, member ASME, was engaged, a clerical staff assembled and housed, and the Survey launched under the general supervision of the afore-mentioned special EJC Committee which was made up of the secretaries of the EJC societies. To make the proposed register worth while it was necessary to prepare a questionnaire to be filled out by individual engineers and to get the questionnaire into the hands of every qualified engineer under circumstances which would insure prompt and thoughtful attention to it. The drafting of the questionnaire was a task for experts familiar with the technical requirements and the fields of engineering specialization. To get the questionnaire into the hands of engineers required lists of names and addresses, and it was here that the engineering societies co-operated so generously and effectively. Each of the five EJC societies and each of thirteen other national societies put the names and addresses of their qualified members on questionnaires and record cards and returned them promptly to the Survey staff. Here dupli-

cations were eliminated and other names, derived from a variety of sources, were added, with the result that 116,183 engineers were asked to fill out and return the questionnaire. Nor did the co-operating societies stop here. They urged their members, by means of publicity carried in their journals, to make the Survey a success. As a result, 73,069 questionnaires were executed and returned to the Survey staff, from which usable records of 63,689 American engineers of high standing, classified according to the 253 specialties in which they are competent and the 10 major fields of activity in which they are engaged, were made available to the Department of Defense.

As soon as the executed questionnaires were returned to the Survey staff they were checked against the master file of names and addresses and were then sent to the Bureau of Labor Statistics, Boston, Mass., for codification and the preparation of a transcription sheet. This step accomplished, the coded questionnaires and transfer sheets were sent to the Navy Department where the questionnaires were microfilmed and the data put on punch cards for mechanical sorting. Questionnaires, microfilms, and punch cards were finally sent to the National Scientific Register, established in the U. S. Office of Education under a grant of funds by the National Security Resources Board. This Register will maintain a roster of scientific and technical personnel for the use of the Department of Defense and other agencies until the recently authorized National Science Foundation is in a position to perform its function in this field.

A majority of readers of MECHANICAL ENGINEERING received the questionnaires and may recall that they were asked to indicate by numerals 1, 2, and 3 the order of the level of their competence in 253 specialized fields of engineering and 10 "activities." It must have occurred to most registrants as it did to the administrators of the Survey that intelligent use of the data demanded approved definitions of the 253 fields and the 10 activities. To meet this need the scope of the Survey was expanded by an amendment to the original Task Order under the contract to include the writing of these definitions. (Here may we tip our hat to a fellow editor, B. G. A Skrotzki, associate editor of *Power* magazine, who prepared 239 of these definitions!) Once again the co-operating societies came to the aid of the Survey project by approving the definitions which related to the specialties within the areas of their own interests.

With the completion of the Survey project EJC has once again demonstrated that it can perform with efficiency and competence the tasks assigned to it that come within the scope of its functions. Once again EJC has been the focal point of co-ordinated action by its member and other societies. Once again EJC has proved that its organization and methods are quick to respond to the call for service, flexible in adaptation to ad hoc situations, and competent to administer, with minimum effort and personnel, projects relating to the national interest.

Here we have an achievement of which engineers, and particularly ASME members, can be justly proud, and a case history which is in a sense an answer to the question, "What Is EJC?"

Charles M. Allen

IT is not intended here to summarize the engineering achievements of Charles Metcalf Allen, professor-emeritus of hydraulic engineering and director of the Alden Hydraulic Laboratory, Worcester Polytechnic Institute, ASME Honorary Member and Warner medalist, whose death occurred on August 15 in the seventy-ninth year of his age. The honors lists of several institutions, the publications of learned societies, the Patent Office, the files of government agencies and companies whom he served as consultant, and the supplement to the John Fritz Medal Book, issued in 1949 at the time Professor Allen received that highest of American engineering awards, are the sources from which a biographer would assemble his material. Two engineering achievements alone—the development of the salt-velocity method of water measurement and a half century spent as a pioneer in hydraulic-laboratory investigations—would be sufficient to insure for him a place among the great hydraulic engineers of the last hundred years, while a less tangible achievement, although perhaps an even more rewarding one to a man of his qualities, was a lifetime of teaching and its impact on the lives of hundreds of young engineers which has marked him as one of the great teachers of our time.

Appropriate as a recital of his successes in these and other fields would be, it would concern itself with achievements, and hence might fail to portray those human qualities which endeared Professor Allen to all who knew him. To name some of those qualities one must fall back on words that have lost their luster and precision through too-common usage and hence are inadequate and unsatisfactory—simplicity, cheerfulness, friendliness, humility, sincerity, kindliness, understanding. Or one can sum it all up in that highest expression of undergraduate praise and simply say, "He was a darn good egg!"—something the man himself would have understood and appreciated. For here was a man so genuine, so vitalizing, so responsive, so heart-warming that to call him Charlie Allen, as everyone did, was not unmannerly or disrespectful familiarity, but a sincere tribute.

For every man who will think of water measurement when the name of Charlie Allen is mentioned, dozens will see a fine-figured, white-haired man, with keen and kindly eyes and a smiling face. They will see the thumb of his left hand caught in the armhole of the vest of his blue suit, revealing a pocketful of cigars. They will retell stories about the kit of tools he always carried with him. They will hear the Yankee twang and feel the friendly arm encircle their shoulders. For every man who will think of hydraulics when the Alden Laboratory is cited, dozens will visualize, not its technical equipment, but the rocking chairs around the fireplace where problems were threshed out and where the influence of a great man seeped into their maturing minds to enrich their lives and quicken their spirits. A college needs equipment, books, buildings, playing fields, and money, but most of all it needs men — men like Charlie Allen.

WHAT PRICE SPEED?[1]

Specific Power Required for Propulsion of Vehicles

By G. GABRIELLI[2] and TH. von KÁRMÁN[3]

INTRODUCTION

THE history of technique and engineering testifies to the irresistible urge of humanity toward increasing the speed of locomotion. Means of locomotion on the ground, on the surface of, and within water, through the air, and perhaps through empty space, compete in an ever-growing effort toward higher velocities. Obviously, there are limitations for every type of locomotion. At a certain speed, any particular type becomes so inefficient and uneconomical that it is unable to compete with other more appropriate types.

It is difficult to find a measure of the comparative economy of locomotion, since it is impossible to find a general measure for the value of speed in human life. Obviously, speed has quite different value in war and peace, in transportation of persons, and of cargo. The appreciation of speed depends upon our whole philosophy of life, that is, on factors far beyond the scope of engineering science.

In this short study, the problem of comparative merits of various means of locomotion is considered merely from an engineering point of view. The power required for transportation of unit weight is used as a measure for the comparison. Evidently for a definite system of locomotion, the minimum of power necessary for transportation of unit weight is determined by the physical laws of the resistance of the medium, the efficiency of the method of propulsion, the unit weight and fuel consumption of the particular type of power plant, and many other factors. Nevertheless, it appears that if one throws all data together, a general trend, almost a kind of universal law, can be found for the power required per unit gross weight of the vehicle as a function of maximum speed. The demonstration of this general trend is the subject of the present contribution. One has to realize that the material is necessarily approximate and incomplete, and the conclusions are of rather tentative nature.

The data for power, weight, and maximum speed are taken, in general, from publications; the data concerning the products of the Fiat concern, from records of this firm. No classified material was used in the plotting of the diagrams.

The authors present their study in this incomplete form to encourage a more complete compilation of statistical material by persons or organizations which are in a better position to do such work. They will be especially glad if manufacturers would speak up and show examples in which the power-weight ratio lies below the minimum curves shown in the accompanying diagrams.

A preliminary examination of the material has shown that it appears justified to separate the data for individual vehicles from the data for trains. It is known that, especially in the case of fast trains, the average resistance per vehicle is substantially smaller than that of a single vehicle. In the first part of this paper, we restrict ourselves to single vehicles. Table 1 gives the types of single vehicles to be considered.

TABLE 1 TYPES OF VEHICLES

I	II	III
(*a*) Commercial ships	(*a*) Motor-driven railway cars	(*a*) Airships
(*b*) Battleships	(*b*) Trucks	(*b*) Helicopters
(*c*) Destroyers	(*c*) Automobiles	(*c*) Private airplanes
(*d*) Submarines on surface		(*d*) Commercial airplanes
(*e*) Submarines submerged		(*e*) Bombers
		(*f*) Fighters

METHOD OF PROCEDURE

The following procedure was employed in the evaluation of the material:

First, an extensive amount of material was collected for each type of vehicle and the power for unit weight (in hp per ton), calculated and plotted as function of the maximum velocity which the vehicle can reach in level motion. The values thus obtained show large dispersion. This appears natural since not all vehicles are designed with a view to obtaining the highest velocity with a minimum power per unit weight. Other factors, such as, for example, the price of manufacturing or design criteria incompatible with minimum power, may prevail. For our purpose, it seems to be logical to determine a limiting curve for each type representing the "minimum" value of the "power per unit weight" as a function of the "maximum velocity."

Hence, from the great number of vehicles of a given class, those examples were selected which have less power for unit weight installed than other vehicles of the same class and same maximum velocity. A continuous curve is plotted through the points representing these selected examples. It must be noted that this curve does not necessarily determine the minimum of the power that is required to transport one ton at a given velocity. It may occur that a vehicle built for higher velocity can be more economical at a lower speed, not using its full power, than a vehicle designed for the same lower speed as its maximum velocity. The exact meaning of the curve is the statement that, according to present experience, in order to design a vehicle of a certain type for a given maximum speed, at least as much power has to be installed as is shown by the diagram.

It must be noted also that the full power installed in the vehicle is used in the computations. This includes, of course, some power which is not used for production of thrust; for example, power used for auxiliary purposes. Also in the case of trucks and railway cars, a certain portion of the power is reserved for climb. In other words, the maximum speed indicated in the diagram is, in general, less than the full speed which could be reached by the vehicle if the full power could be utilized on a horizontal track. These types of vehicles are often designed in such a way that the maximum power is not available for the horizontal run. To minimize this effect, such examples were selected for which the power reserve at the maximum speed is relatively small. On the other hand, the necessity of such power reserve corresponds to the nature of the vehicle and, therefore, it appears justified to use the full power for the comparison with other types.

[1] 1950 Thurston Lecture.

[2] Director of Engineering, Fiat Company, Professor Politecnico, Torino, Italy. Mem. ASME.

[3] Honorary Professor, Columbia University; Chairman of the Scientific Advisory Board of the USAF; Consultant of the Aerojet Engineering Corporation, Azusa, Calif. ASME Medalist, 1941. Mem. ASME.

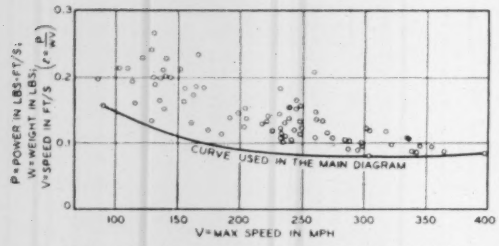

FIG. 1 EVALUATION OF DATA FOR COMMERCIAL PLANES

Fig. 1 represents an example of the evaluation of the data related to one type of locomotion, namely, commercial airplanes. The diagram contains 85 points representing 85 airliners—old and new—with a maximum speed between 80 and 395 mph. The nondimensional quantity ϵ plotted as ordinate is the ratio between the maximum power P and the product gross weight W times velocity V. The quantity P/V is the tractive force which would correspond to full use of the power P for propulsion with a propulsive efficiency of 100 per cent. Then $\epsilon = \frac{P}{WV}$ is the ratio between this tractive force and the weight of the vehicle. Evidently, if one compares two vehicles and considers the work necessary for a given transport performance, i.e., the transportation of the same gross weight over the same distance, this work is directly proportional to ϵ. For example, in the case of commercial aircraft, the diagram shows that an optimum for power requirement exists at a speed of approximately 320 mph. As a matter of fact, the increase of maximum speed from 200 mph (say, from the DC-3) to 360 mph (Constellation or DC-6) has been achieved by actually decreasing the work necessary for the same transport performance. The amount of work increases only slightly if the speed is raised to 400 mph.

If we consider the propulsion problem from the viewpoint of the resistance of the medium, ϵ is the ratio between a kind of total resistance which includes in addition to direct drag, the drag equivalent to losses in the transmission and in the propulsive mechanism—and the gross weight of the vehicle. It is a kind of global friction coefficient for the vehicle. We call it the coefficient of the specific tractive force or specific resistance.

It is apparent that this coefficient is useful for the comparison of different types of transportation, since it gives an indication of the price one has to pay in power for speed, and it helps to find out whether a certain system of transportation is suitable for further speed increase without penalty of higher specific-power requirement or whether one is near the economical limit. Of course the real measure of economy should be the work necessary to transport certain useful load, over a given distance. Therefore, our conclusions—in so far as economy is concerned—are strictly correct only if the ratio of useful load to gross weight remains constant. The authors hope that somebody will carry further the present analysis substituting the useful load for the gross weight. Since exact information concerning useful load is not easily available to the authors, they decided to use the gross weight as parameter.

In the following paragraphs we shall consider the three main classes of vehicles somewhat in detail.

MARINE VEHICLES

Fig. 2 shows the curves representing the minimum specific power (i.e., built-in horsepower divided by gross weight), as a function of maximum speed for various types of single vehicles. Fig. 3 shows the specific tractive force, i.e., the power per unit weight divided by the maximum velocity. Both diagrams show that nautical vehicles have the lowest values for specific power or specific tractive force at least at low velocities. Evidently this fact makes ships the most economical single vehicles at low speed. The diagrams also show that for medium speeds the terrestrial and, for high speeds, the aerial vehicles represent the optimum cases.

Generally speaking, the power required for ship propulsion consists of four contributions:

(*a*) The skin friction acting on the wetted surface.
(*b*) The pressure drag produced by eddy or wake formation.
(*c*) The wave resistance.
(*d*) The air resistance of the superstructure.

The frictional resistance can be considered proportional to the square of the velocity, the density of the water, and the wetted-surface area, multiplied by a coefficient which essentially depends upon roughness of the surface, and a dimensionless parameter known as Reynolds number. For a smooth surface, the friction coefficient decreases with increasing Reynolds number, i.e., it is smaller for large boats than for small boats. For rough surface, the coefficient is essentially independent of speed. The eddy resistance behaves in general similarly to the frictional resistance. Fig. 3 shows that in the speed domain in which these two components of the resistance predominate, the specific tractive force, for example, in the case of merchant ships, shows a moderate increase with speed. For the same vehicle, the specific tractive force would be approximately proportional to the square of the speed. However, if we consider ships of different sizes, then ships of large displacement are better off because the wetted surface increases more slowly than the displacement, i.e., the gross weight. Therefore the increase of the specific tractive force in our diagram is much slower than that predicted by the quadratic law. It

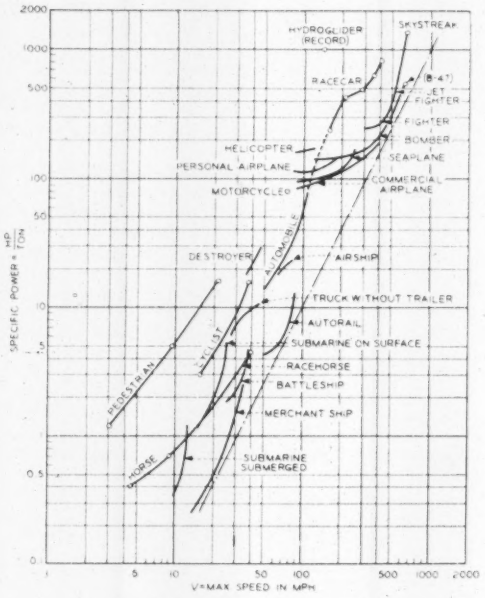

FIG. 2 SPECIFIC POWER OF SINGLE VEHICLES

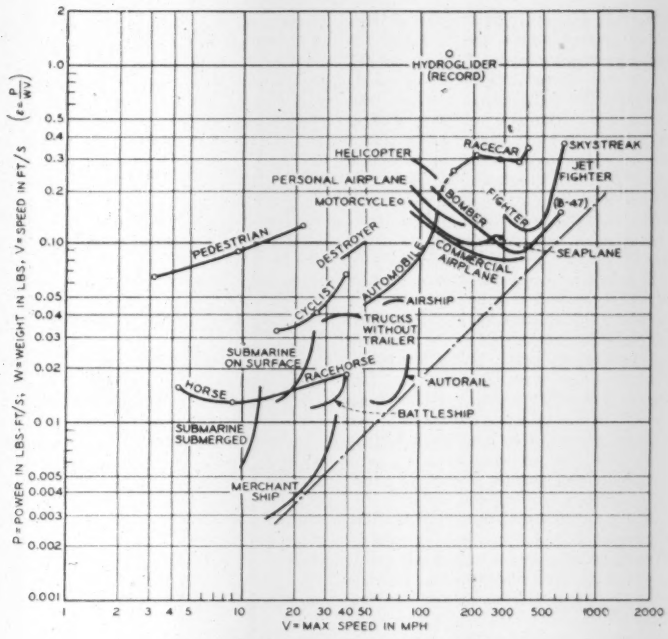

FIG. 3 SPECIFIC RESISTANCE OF SINGLE VEHICLES

appears, nevertheless, that at least in the practical speed domain, the slowest ship requires the least tractive force.

On the other hand for both merchant and battleships, the specific tractive force shows a rapid increase in the speed range between 30 and 40 mph. The reason for this increase is the increasing wave resistance which depends upon another dimensionless parameter known as Froude number. This parameter may be defined by the formula $V/\sqrt{gL}$, where V is the speed, g the acceleration of gravity, and L an appropriately chosen linear dimension of the ship, for example, the length of the water line. As the speed becomes of the same order of magnitude as the velocity of propagation of the predominant wave produced by the motion of the ship (which velocity is proportional to the quantity $\sqrt{gL}$), the wave resistance rapidly increases. The only effective remedy against this obstacle to speed increase is to increase the length of the ship. This measure is limited, however, by several factors, one of which is the increase of structural weight due to high bending moments, furthermore, capital investment, and also the practical limits of maneuverability. Docking and the like also limit the size of a ship. The compiled data show that, for example, in the case of merchant ships, the tangent to the curve shown in Fig. 2, at the present speed limit actually reached is about 6:1, which means that for a speed increase of about 1 per cent, the built-in power per ton must be increased by about 6 per cent. A similar result is shown for battleships. Evidently, these means of locomotion are approaching speeds at which further increases appear uneconomical.

The destroyers are shown in the diagrams operating in the speed range between 35 and 50 mph. This operation requires about 8 times larger tractive force per unit weight as required, for example, for a large commercial liner. Of course these vehicles are not built for economical operation at such high speeds. Their main feature is maneuverability in battle conditions. Their maximum speed is limited rather by cavitation characteristics of the propellers than by increasing wave resistance.

The specific tractive force required for the submarine on the surface is considerably larger than for merchant ships or battleships. This is due partly to the fact that they are not built primarily for surface locomotion and partly to the limitations of their size. The submarine in submerged state faces frictional and eddy drag only. The diagram shows a rather surprising increase of power required with increasing maximum speed. Such an increase of power does not seem necessary from a hydrodynamic point of view and must be connected with the particular specifications for the design of the submarines considered. It is to be noted that recent progress in submarine design is not included in our figures.

TERRESTRIAL VEHICLES

The resistance of terrestrial vehicles can be separated into three components. These are as follows:

(*a*) Rolling friction.
(*b*) Air resistance of the body.
(*c*) Air resistance of the rotating wheels.

In addition, since our definition of tractive force is based on total power built into the vehicle, the transmission losses are included.

In examining Fig. 3, a large disproportion in specific tractive force required for trucks and passenger automobiles, as compared to rail cars, is evident. This is explained sufficiently by the difference in the rolling friction between pneumatic tires and road, as compared to the rolling friction between steel wheels and rail. In the case of the rail car, we find that at relatively low speeds (between 50 and 70 mph) the specific tractive

force is essentially independent of speed. As a matter of fact, at these speeds the greatest portion of the total resistance is contributed by the roll friction which is essentially proportional to the load on the wheels and almost independent of speed. As the relative contribution of the air resistance increases, the specific tractive force increases. The rate of increase of ϵ, however, is not determined directly by the law of air resistance which would make the tractive force proportional to the square of the speed; the increase of power at a higher rate is due to several factors, such as the necessity of a climb reserve which prevents the use of the total power built in at high-speed level run.

Similar conditions prevail in the case of automobiles. A recent analysis carried out by Romani for the French Center for Studies in Automobile Engineering shows that in the case of a nicely streamlined automobile, which is supposed to have a drag coefficient equal to about 0.3, referred to the master cross section of the car, the air resistance becomes equal to the rolling resistance at a speed of about 40–45 mph. At higher speeds, the air resistance becomes more and more the controlling factor. For commercial passenger cars, 125 mph can be considered as the highest speed. The curve shows that also in this case the installed power per unit weight is larger than would be strictly necessary following the law of air resistance.

It is interesting to note, however, that the increase of power required is much more moderate for racing cars. This is due (1) to better streamlining, i.e., reduction of the coefficient of the air resistance; (2) to the fact that the design of race cars allows the use of full motor power in level run at maximum speed. As a matter of fact, if we compare the specific tractive force for the car holding the present speed record with a standard passenger car which has 120-mph maximum speed, we find that the ratio between the respective values of the specific resistance is equal to about 3, whereas the ratio between the squares of the velocities is about 11. For vehicles of the same size and shape, whose resistance consists essentially of air resistance, the two ratios should be equal. Of course, in addition to the points mentioned in the foregoing, it must be considered that the rolling resistance is also reduced in the case of the racing car by use of special tires and roadbeds.

For motorcycles, only one point is shown in each diagram since there is little difference between the performance of different makes of motorcyles. The comparison shows that the motorcycle is a rather prodigal device for locomotion. This may be due partly to the relatively large air resistance which is produced by the wheel itself and the parasite drag of the bodies exposed to wind. It has to be pointed out, however, that the ratio of useful load to total weight is very favorable in the case of the motorcycle.

It is interesting to see that the tractive force of single trucks (without trailer) is practically independent of speed in the speed range between 30 and 50 mph where the rolling friction is the determining factor, and the curve representing trucks constitutes almost a continuation of the curve representing passenger automobiles.

AERIAL VEHICLES

Aerial vehicles are predominant in the high-speed range, especially in the speed range above 150 mph. There is one notable exception, that is the lighter-than-air craft—the airship. In its own speed range, the airship appears several times more favorable—at least in the sense considered in this paper—than the helicopter. This does not mean, of course, that the airship can replace a helicopter. The latter is a short-range device, with excellent ability to take off and land almost everywhere. The airship is a long-range means of transportation requiring special landing installations. The specific tractive force of the airship is of the same order as that of the truck or the automobile. It is also seen that in the speed range in which airships were used, the specific tractive force does not show any increase with increasing speed. One may therefore conclude that it should be possible to design airships of considerably higher speed (say, 120 mph) without any significant increase of the work necessary for a given transport performance. For this aim, the size of the airships has to be enlarged considerably and this may require the solution of new structural problems as well as new methods of propulsion; significant aerodynamic improvements may also appear feasible. At present the difficulties of handling of very large ships and the need of relatively large capital investment seem to be the main impediments to the revival of airship development. On the other hand, its large cargo capacity and the comfort of travel yet may secure a place for the airship in transoceanic travel in a speed range between those of the large passenger ship and the commercial airliner.

Proceeding to some remarks concerning heavier-than-air craft—especially airplanes—let us consider Fig. 3, i.e., the diagram showing the specific tractive force as a function of the maximum speed. The large specific tractive force required at low speed is a characteristic feature of all airplanes. It is apparently an unavoidable consequence of the fact that the airplane has to provide its own sustentation by power. This is, of course, also true in the case of the helicopter and of the bird-imitating ornithopter which, however, has not yet reached any stage of practical application. In so far as commercial air transport is concerned, this fact is a fundamental restriction in the application of the airplane. Whereas in the domains of ship, railway, and automobile transportation, it is possible to build high-powered fast vehicles for passenger transport and low-powered slow vehicles for inexpensive cargo, the same problem has not been solved yet so far as air transport is concerned.

Let us glance for a moment at the diagram showing the power required per ton for various airplanes (Fig. 2).

For all airplanes, the minimum number of horsepowers required for 1 ton weight is greater than 110. This corresponds to a power loading of about 50 lb per hp. This does not mean that no airplane can be designed to carry more than 50 lb per hp. However, this value of the power loading appears at the present time as a highest limit for an economically possible airplane. It also represents a reasonable limit for take-off. To be sure, jet-assisted take-off may change the take-off limitations. One sees, furthermore, that the ratio between the speed of the fastest commercial airplane and the slowest private plane in use is about 4.5:1, whereas the ratio between their specific powers is less than 2:1. There are two reasons for this fact: (1) Airplanes with low wing loading have, in general, relatively low structural efficiency. When the size of such a lightly loaded plane is increased, the empty weight goes up to such an extent that pay load and range shrink to small uneconomical items. (2) Small airplanes have in general a less favorable lift-drag ratio than large airplanes because the parasite drag constitutes a larger portion of the total drag. Whether a low-powered glider with excellent lift-drag ratio could reach sufficient popularity to make its manufacture and sale economically feasible, is yet an undecided question. Maybe if a small jet or turboprop engine could be manufactured at low cost, the present situation would change.

It has been mentioned already that the speed of commercial airliners has been greatly increased without penalty to their economy. In this development—in addition to aerodynamic improvements—the realization of high-altitude air transport played a significant role. The spectacular increase of speed of bombarding aircraft is due mainly to the increase of size and flight altitude.

It is quite instructive to look at the diagram representing the specific tractive force for airplanes (Fig. 3). By its definition, this quantity is equal to the drag-lift ratio of the plane divided by the propulsion efficiency. The optimum ratio for commercial airliners is about 0.08, corresponding to a lift-drag ratio of 12:1, or taking into account the propeller efficiency about 14:1. This figure is proof of the rather highly developed state of aerodynamic design. In the case of fighters, the optimum occurs at a speed of about 400 mph, and the best value is 0.118, which is yet an excellent figure if one takes into account the fact that fighters are not primarily designed for economy—that economy must be sacrificed for maneuverability and offensive armament, which means unavoidable parasite drag.

We have seen that in the case of ships, the increase of wave resistance at a certain Froude number increases greatly the power required. In a somewhat analogous way, the airplane has to overcome the so-called compressibility effects, when one approaches sonic velocity, i.e., Mach number 1. This is clearly shown in the diagrams. For example, in Fig. 2, the horsepower per weight ratio increases rapidly between 500 and 600 mph speed, and a corresponding increase of the tractive-force coefficient appears in Fig. 3. It is known, however, that by the use of so-called sweptback wings, the critical Mach number can be increased, and the rapid rise of the drag delayed to a higher speed range.

The relatively favorable values for the B-47 bomber are probably due to the effect of sweep back. The data for fighters with sweptback wings are in general not yet available for publication, but they probably would yield points between those representing the Skystreak and the B-47 bomber.

There are no published data available for airplanes with supersonic velocity at level flight.

Our representation of jet planes is not quite consistent with that of propeller-driven airplanes. For jet planes, we used the static thrust of the engine divided by the gross weight of the airplane for the calculation of the specific tractive force. Similarly, we used thrust horsepower for the calculation of the horsepower per ton ratio. It was felt that it is difficult to say what is the meaning of "built-in power" in the case of the jet engine. The use of the thrust horsepower for the comparative computation gives some advantage to the jet engine, because in the case of the conventional airplanes, the shaft horsepower was used which is equal to the thrust horsepower divided by propulsion efficiency.

LIVING VEHICLES

For curiosity's sake, the authors included some data concerning the man, walking and running, the man on bicycle, and the horse. They did not attempt to discuss quantitatively the case of fish and fowl, nor that of the man swimming in water.

The main difficulty in the case of a living power plant is the estimate of the effective horsepower, which greatly depends upon the duration of the effort used in locomotion. After consulting some publications on the matter, Table 2 was compiled and the data given in the table were used for the diagrams.

It has to be realized that these data are somewhat arbitrary. Nevertheless, one can make interesting observations; for example, the power per weight ratio is almost identical for the fastest racehorse and the fastest battleship at about the same maximum speed. It is the belief of the authors that it would be of interest to analyze sport records concerning swimmers, marathon walkers, runners, horse and dog races, and the like, from point of view of the performance of the human and animal power plant.

COMPOSITE VEHICLES

Composite vehicles are in use on the ground, on the water surface, and in the air. We want to restrict ourselves to the terrestrial vehicles. The tugboat is employed mostly for river and canal transportation, and at low speeds; it is rather impractical on high sea. The glider train has been used as an aerial composite vehicle, but the advantages of such an arrangement are not very great, in so far as saving of power is concerned. It has been suggested that aerodynamic advantages could be realized by coupling airplane wings end by end because the tip losses would be essentially reduced. Similar effect is realized in formation flight of birds and also of airplanes. There are, however, not many data available on this subject.

TABLE 2 DATA ON LIVING POWER PLANTS

Kind of locomotion	Weight, lb	Speed, mph	Power, hp
MAN—WALKING AND RUNNING			
Walking	155	3	0.084
Marching fast	135	9	0.30
100-yard runner	122	22.4	0.90
MAN—ON BICYCLE			
Pleasure trip	185	15.5	0.25
Speeding on highway	160	25.0	0.47
On racetrack	155	38.1	1.01
HORSE			
With carriage, at fast step	3500	4.5	0.64
With carriage, trotting	2650	9.0	0.85
Racehorse in gallop, with jockey	1000	38.5	2.0

Fig. 4 represents the curves for power per ton at maximum speed for tractors and trucks with trailers and various types of trains. The reduction of power required per unit weight is due to several reasons: (1) Especially in the case of fast trains, the air resistance of the complete train is considerably less than the sum of the air resistances of the single cars used separately. (2) The concentration of the propulsive power in the locomotive allows the employment of large power-plant units, with better efficiency and lower specific weight. It is seen, however, that the trains driven by electromotors fed from power lines have higher power per weight ratio than, for example, the Diesel-electric and steam-driven passenger trains.

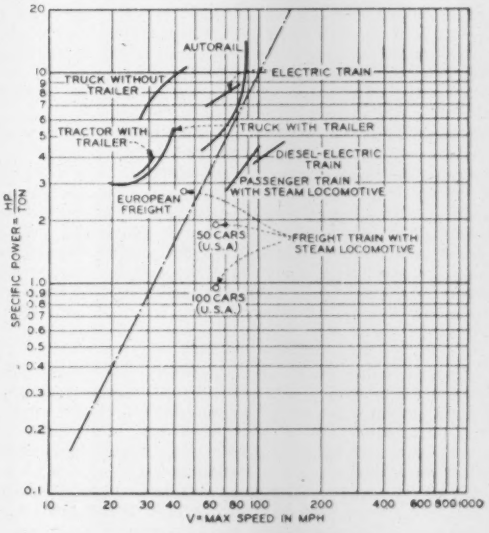

FIG. 4 SPECIFIC POWER OF CONVOYS

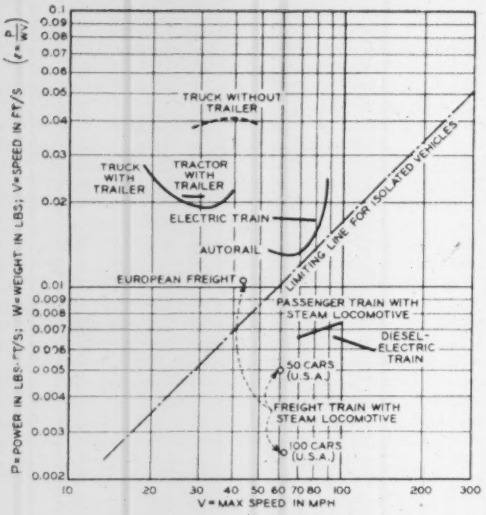
P = POWER IN LBS-FT/S; W = WEIGHT IN LBS; V = SPEED IN FT/S
V = MAX SPEED IN MPH
TRUCK WITHOUT TRAILER
TRUCK WITH TRAILER
TRACTOR WITH TRAILER
ELECTRIC TRAIN
AUTORAIL
EUROPEAN FREIGHT
LIMITING LINE FOR ISOLATED VEHICLES
PASSENGER TRAIN WITH STEAM LOCOMOTIVE
DIESEL-ELECTRIC TRAIN
50 CARS (U.S.A.)
FREIGHT TRAIN WITH STEAM LOCOMOTIVE
100 CARS (U.S.A.)

FIG. 5 SPECIFIC RESISTANCE OF CONVOYS

They are even less favorable than single rail cars. The reason is probably the speed limitation by the method of transmission of electric energy from the power line to the locomotive. Because of this limitation, the designers of such trains may not have made such effort for power economy as, for example, have the designers of Diesel-electric trains.

The fast freight train is, no doubt, the most economical type of transport in the speed range between 40 and 60 mph in so far as power required is concerned. The data show a wide dispersion, according to the different number of cars in the train and different size and design of the cars themselves. For American freight trains, one obtains a specific tractive-force coefficient of the order of 0.0025 at 60-mph speed, which means that a tractive force of about 5 lb is sufficient to move 1 ton weight at this considerable speed. This figure is to be compared with 0.04 for trucks at the same speed and with 0.08 for airplanes at a speed of 200–300 mph. Unfortunately, as it has been pointed out previously, it is not possible to construct airplanes with reasonable economy at low speeds in order to compete with the railroad in cargo transport. For a speed of 60–80 mph, the coefficient of tractive force would be of the order of 0.2. Consequently, the railroad men should have the consolation that the railway age is not yet terminated. The partial change over from railroad to trucks, which occurred in the recent past, is mainly due to the greater flexibility of the truck system and lesser handling costs of the cargo carried by trucks.

GENERAL DISCUSSION

Let us return to the diagrams pertinent to single vehicles. We observe in both Figs. 2 and 3 that all curves lie above a certain limiting line. In other words, for every class of vehicle there is a certain limiting speed beyond which the vehicle becomes uneconomical. The increase of specific resistance with speed for a given vehicle is determined by the law of resistance for the method of locomotion considered. Such resistance laws, in general, depend on various characteristic dimensionless quantities. For example, the law of resistance for ships depends upon the Reynolds number and the Froude number. The Reynolds number determines the ratio between inertial and frictional forces. It contains the density and viscosity coefficient of the fluid medium, a characteristic length of the vehicle and its speed. The Froude number represents a ratio between inertial forces in the fluid and gravity. It is composed of the velocity of the vehicle, a characteristic length, and the acceleration of gravity. The law of resistance of terrestrial vehicles depends primarily on the coefficient of rolling friction and the coefficient of the air resistance. The best values of these coefficients for practically possible shapes are more or less given. However, if we consider the law of similarity of similarly designed vehicles of different sizes, we find that the ratio between air resistance and weight depends on a non-dimensional parameter quite analogous to the Froude number, since the weight of the vehicle increases with the third power of the length, and the air resistance with its second power. The same parameter enters also into the analysis of aerial vehicles. In addition, the Reynolds number has an influence as far as the frictional resistance of the vehicle is concerned, and the Mach number as far as compressibility effects enter into the picture.

The consideration of all these parameters, however, does not give a full explanation of the limitations of speed which we investigate in this paper. For example, theoretically speaking, the increase of size or at least the length would prevent the rapid increase of resistance per weight ratio which limits the speed of the boats by keeping the Froude number sufficiently low. Why cannot this be done? Of course, increase of size has practical disadvantages which are difficult to be put into equations. The main limitations, however, are certainly those imposed by structural considerations.

It is necessary, therefore, to investigate which dimensionless parameters should be construed to express the similarity relations between structures of different sizes. The structural efficiency of a vehicle depends certainly on the specific weight γ of the construction material and the allowable stress σ_a for the same material. The ratio between allowable stress and the specific weight has the dimension of a length so that the quantity $\gamma L/\sigma_a$, where L represents the characteristic length of the structure, is a dimensionless quantity. As a matter of fact, if we replace the allowable stress by the ultimate stress σ_u of the material, the quantity $\gamma L/\sigma_u$ becomes the ratio between the length of the vehicle and the so-called length of rupture of the material. The length of rupture is the length of a vertically hanging rod which would break under its own weight.

If we introduce such a structural parameter into our considerations, it appears more understandable that every class of means of transportation approaches a speed limit beyond which no practical design is possible. If we eliminate the length L between the Froude number $V/\sqrt{gL}$ and the structural parameter $\gamma L/\sigma_u = \rho g L/\sigma_a$, we obtain a new parameter which can be written in the form $V/\sqrt{\sigma_u/\rho}$. It is easily seen that this parameter is dimensionless, since the quantity σ_u/ρ has the dimension of the square of a velocity. As a matter of fact, the velocity $\sqrt{\sigma_u/\rho}$ can be given a mechanical interpretation. One can imagine a thin ring built of a material with the ultimate strength σ_u and the density ρ. If one rotates such a ring with the circumferential velocity V, the quantity $\sqrt{\sigma_u/\rho}$ represents the speed at which such a ring would break under the action of the centrifugal forces.

It is interesting to compare approximate values of the quantity $\sqrt{\sigma_u/\rho}$ for various construction materials. Such a comparison is given in Table 3 for a few materials.

In addition to the stress-density ratio, the table also incorporates the ratio between elastic modulus and density. The

TABLE 3 COMPARISON OF $\sqrt{\sigma_u/\rho}$ AND $\sqrt{E/\rho}$ FOR VARIOUS MATERIALS

Material	E, psi	Yield point, psi	Tensile strength, psi	Density ρ slugs/cu ft	$\sqrt{\sigma_u/\rho}$ fps	$\sqrt{E/\rho}$ fps
Structural steel	30×10^6	50000	80000	15.25	870	16800
Stainless steel	29×10^6	40000	80000	15.05	875	16600
Heat-treated steel	30×10^6	110000	150000	15.25	1190	16800
Dural 24S-T	10.4×10^6	48000	65000	5.4	1320	16650
Titanium (at present)	15×10^6	90000	120000	8.7	1410	15800
Titanium (in development)	15×10^6	150000	180000	8.7	1725	15800

quantity $\sqrt{E/\rho}$ has also the dimension of a velocity. As a matter of fact, it is directly proportional to the velocity of propagation of sound in the material concerned. It is remarkable that it has almost the same value for all the material considered in the table.

Since the stresses, in general, and especially dynamic stresses, are dependent upon the speed of the vehicle, and on the other hand a limiting line, which should be valid for all types of vehicles, cannot depend upon parameters containing quantities related to specific media or specific types of vehicles, it is probable that the values of the dimensionless parameters

$$V\Big/\sqrt{\frac{\sigma_u}{\rho}} \quad \text{and} \quad V\Big/\sqrt{\frac{E}{\rho}}$$

have a determining influence on the limitations of speed. The elastic modulus enters in the resistance against buckling and in the flexibility of the structure, which also may introduce limitations. In certain structures, for example, thin-walled so-called monocoque structures, combinations of the ultimate stress and the elastic modulus determine the allowable ultimate load. Hence both dimensionless structural parameters may have influence on speed limitations.

According to the evidence of our collected material, the minimum value of the specific resistance ϵ of single vehicles seems to follow a trend which indicates that the over-all minimum value of ϵ is approximately proportional to the speed of the vehicle. The equation of the limiting line shown in Fig. 3 would be $\epsilon = .000175V$ where V is the speed in mph. However, further analysis of the various vehicle systems is necessary to decide whether or not a general law expressed in the dimensionless parameters

$$V\Big/\sqrt{\frac{\sigma_u}{\rho}} \quad \text{and} \quad V\Big/\sqrt{\frac{E}{\rho}}$$

can be established.

It is, however, an interesting question whether, and in which way, further increases of velocity of locomotion may be possible without paying the penalty for speed.

First there is the question of how far propulsion efficiency can be increased. In most cases of vehicles of high-quality design, the propulsion efficiency is almost at the optimum limit. The improvement of thermodynamic efficiency of the power plants may radically change the range of various vehicles, but enters only indirectly into the consideration of the specific resistance or the power-weight ratio. For example, a prime motor with lower weight and lower consumption may make it possible to increase the size of a boat in order to come into a more favorable Froude-number range without becoming utterly uneconomical.

There is also the question of novel methods of propulsion: For example, the drag coefficient of surface vessels may be decreased very essentially by lifting the bulk of the floating structure above the water level and supplying sustentation by hydrofoils. We do not attempt to estimate the effect of such a radical innovation. Whether the trials until now appear promising is a question of individual judgment. In the field of aerial vehicles, the long-range rocket shot into high altitude and gliding from the ionosphere to a distant point on the earth may represent a new method of transportation. This case does not fit easily into our computations because it does not represent level flight but a combination of ballistics and glider technique.

According to computations of H. S. Tsien, a rocket with an average speed of 4500 mph over a 3000-mile range would require a thrust of 190,000 lb of 140 sec duration. This total impulse, distributed over the total flight duration of 40 min, corresponds to an average thrust equal to 11,100 lb. The initial weight is estimated to be equal to 96,000 lb and the final weight to 19,000 lb. With 57,500 lb as average weight, the specific resistance would be equal to $\epsilon \sim 0.2$. This figure is, of course, excellent for such tremendous speed. On the other hand, the ratio between useful and total weight is extremely low as compared to level-flying aerial vehicles.

Disregarding, however, such speculative means of transportation, it appears from the considerations of this paper that probably substantial increase in speed could be realized if new materials with increased stress-density ratio could be made available. If the quantity $\sqrt{\sigma/\rho}$ could be increased essentially beyond the present limits, evidently the limiting line of the specific resistance versus speed would be displaced to higher values of the velocity. At a recent date, titanium alloys seem to give such promise. High-rate titanium alloys, manufactured at reasonable prices, may substantially change the results of the present analysis.

Canadian Jet Fighter

THE Avro Canada Canuck CF-100, said to be the most powerful fighter in the world, flew from Toronto to Boston recently at an average speed of 555 mph.

The long-range, all-weather, twin-jet fighter, first of its type, covered the 444-mile route in 48 min.

Recently the Canuck flew from Toronto to Montreal at 638 mph, believed to be a Canadian record. Its top speed is still on the secret list.

Designed for the defense of North America, the new day-night fighter will complement the F86A Sabre, the RCAF's standard day fighter. It made its first flight January 19, 1950, and since this time another preproduction model of the aircraft has been built.

The Canuck is presently fitted with Rolls Royce Avon turbojet engines but it is planned to fit later models with Avro Canada Orendas. These are now being tested in the air in a special Lancaster flying test bed. It is also planned to install these Orendas in the RCAF Sabre fighters.

Although of original Canadian design, it incorporates the best features from the considerable fighter manufacturing experience of the United States and the United Kingdom. In planning the aircraft, care was taken not to duplicate aircraft building plans elsewhere. The effort was and is being taken to choose equipment for it which could be easily obtained on this continent.

TAXES *and* ECONOMIC INCENTIVES[1]

By RALPH E. FREEMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE remark "we owe it to ourselves" is frequently heard with reference to the public debt. In a sense, this statement is true of all but that portion of the debt that is held by residents of other countries. The money collected to pay interest and principal is taken from the general body of taxpayers and transferred to those who hold the government securities. The process is a redistribution of the national income and does not directly reduce the total.

The statement just quoted does nevertheless convey a false impression. The transfer of income from taxpayers to bondholders may indirectly cut down the national income and thus cause a reduction in the standard of living. This result comes about by the effect of taxation on economic incentives—the incentive to establish new businesses, the incentive to expand existing enterprises, the incentive to invest, and the incentive to work. If taxes are so great or levied in such a manner as to impair any or all of these incentives, the volume of production will be lowered. This question is discussed in a recent book published by the Brookings Institution.[2] The principal taxes now in force are appraised and their economic effects are examined.

FOUR PRINCIPAL CLASSES OF TAXES

The analysis is focused on four principal classes of taxes—income, sales and excise, property, and payroll. These taxes account for almost 95 per cent of the combined tax revenues of federal, state, and local governments, and the following general conclusions are stated in the summary, chapter 9:

1 The establishment of new businesses is not greatly affected by taxes.

2 Decisions relating to business expansion are influenced especially by the corporate income tax.

3 The corporate income tax limits the expansion of small and moderate-sized firms that do not have access to central capital markets.

4 Personal income taxes tend to curtail the volume of savings available for investment.

5 Incentives to work are not materially affected by taxes.

6 Property and payroll taxes do not have significant influence of economic necessities.

As one would expect from these conclusions, the major part of the book is taken up with an analysis of income taxes—corporate and personal. In discussing the former the author considers problems related to the determination of the tax base as well as the question of the rate itself. He comes to the conclusion that there is no rational ground on which a corporate income-tax rate as high as 38 per cent can be justified in time of peace.

"To the extent that this tax is passed on to consumers, it is little more than a species of sales tax: it is a net income tax only in a nominal sense. On the other hand, for firms which for one reason or another are unable to pass on all or a substantial portion of the tax, it is a highly discriminatory and repressive levy" (p. 109).

In dealing with personal income taxes the author points out that investment decisions are influenced by the marginal tax rate—the rate applicable to the last bracket of income. He states that because of the current high marginal rate, stockholders seem to be less willing than formerly to increase their commitments to companies whose stocks they own and that, in general, individuals most able to assume the risks of investment are those most likely to be deterred by present tax rates.

Mr. Kimmel makes three major recommendations with regard to income taxes: (1) a reduction in the corporate tax, (2) a reduction of the top-bracket rate on personal incomes to 65 per cent, (3) co-ordination of corporate and personal income taxes. Co-ordination might be accomplished by breaking down the present corporate rate of 38 per cent into two components: (*a*) a corporate income tax of 21 per cent, (*b*) a normal tax of 17 per cent which would be deducted from dividends and for which stockholders could claim credit against their personal income-tax liabilities.

HOW PLAN WOULD WORK IN PRACTICE

The way this plan would work in practice is shown in Table 1.

TABLE 1

Computation of Tax	
Corporate profits	$10,000,000
Corporate income tax (21 per cent)	2,100,000
Profits after corporate tax	$ 7,900,000
Normal or first-bracket tax (17 per cent)	1,343,000
Profits after withheld tax	$ 6,557,000
Payment of Dividends	
Dividends declared	$ 5,000,000
Stockholders' tax withheld (17 per cent)	850,000
Cash dividends	$ 4,150,000
Retained Corporate Profits	
Profits after corporate tax	$ 7,900,000
Dividends declared	5,000,000
Gross retained profits	$ 2,900,000
Prorata part of normal tax (17 per cent)	493,000
Net retained profits	$ 2,407,000

The author has presented a sane and carefully reasoned analysis of the effect of taxes on economic incentives. He has avoided making statements that cannot be supported by evidence of some kind, though, of course, in dealing with a problem of this sort, evidence in the form of facts and figures is difficult to obtain.

Even though some of the discussions would have to be modified to fit wartime conditions, the central problem of the book is a timely one. The impact of taxes on economic incentives was relatively unimportant when tax revenues were small. But today, when government in the United States takes about 25 per cent of the total income of the people, the effect of taxation on the volume of production is a matter of grave concern to all citizens.

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Taxes and Economic Incentives," Brookings Institution, Washington, D. C., 1950, p. 212.

STYLING *the* MACHINE TOOL

By FRANK BURGESS[1] AND HAROLD SIZER[2]

BROWN & SHARPE MANUFACTURING COMPANY, PROVIDENCE, R. I.

ARE those who buy or specify machine tools influenced by appearance? Purchasers have long prided themselves on their practical evaluation of machine tools. They want facts, demonstrations of production rates, samples showing accuracy and surface finish, lubrication diagrams, material specifications, and assurances of long service life. Does appearance play any part in this practical appraisal? We believe it does, and one reason for this belief is the general reaction to the laborsaving finish used on machine tools during the war period. Too many man-hours were being used in filling and sanding cast machine surfaces. By painting directly on the cleaned cast surface this time could be saved. The resulting painted surface was rough but highly practical. It had no influence on the production capabilities of the machines and they could still grind to tenths—remove as many cubic inches of metal or drop off as many finished pieces per hour. Nonetheless users did not like this rough finish, and we were soon explaining with the familiar plate, "Painted surfaces on this machine conform to orders of the WPB." As soon as restrictions were lifted, machine-tool manufacturers again were filling and sanding—proof that appearance is a factor which is not ignored by our practical customers.

A well-styled machine creates interest, and a buyer is ready to listen to the story of what the machine can do. The styling also can do a subtle but effective job in emphasizing the features of a machine. If a concern is offering a powerful machine, sturdy and rigid, with a reserve of power for tough cuts, the styling can suggest these qualities, and by its presentation of masses create the feeling of power or strength. Similarly, if a small "light-type" machine is being offered, which is sensitive and easily operated, the styling can subdue mass effects and suggest the light responsive qualities it is desired to emphasize.

Function. In machine tools the practical requirements of the design come first, and function is not sacrificed or compromised for appearance. If 1 hp is needed we cannot adopt a $\frac{1}{2}$-hp motor just because it gives a more compact better-proportioned appearance on the machine column. If a dust exhaust hood is bulky and its flexible hose an unwanted snake coiling around the machine, we cannot discard it to improve appearance. If the convenient working height of a machine table is 40 in. above the floor, we cannot, like the artist painting bathing beauties, increase leg lengths to get more pleasing proportions.

An operator may admire the modern appearance of a machine but he isn't willing to "break his back" 8 hours a day for that appearance. Designers of household appliances may crowd their mechanisms into inaccessible corners to get a smart outer form, and automobile designers may crush a million hats to get that "fast-back" line, but in machine tools, function is vital, and sound engineering principles are not made to yield to esthetics.

The supremacy of function makes the job of a machine-tool stylist a difficult one. In general, little can be done by a final face lifting and machines, Fig. 1, with afterthought ornamentation or "draped-on" effects show a lack of sincerity. The appearance so obtained is as apt to hurt as to help in the presentation of the machine. Good looks should be built in and should grow with the design.

The stylist should be in close touch with the designers from the start of a design. In the early or fluid stages of a layout, there may be several possibilities in the arrangement of a mechanism and in the grouping of mechanisms to form a machine. At this time the suggestions of the stylist often can be adopted, and the planned appearance becomes an integral part of the machine.

Block Form. An expressive and useful design theme for machine tools is the "block form." It is an easy form to manipulate and is readily produced by fabrication and by casting. Fig. 2 shows an application of square and rectilinear forms. These forms have a stable appearance and combine well with cylindrical members which are of course common in machine tools.

Edge Radii. Sharp edges where two planes intersect are not practical in castings and may look "tinny" in sheet metal or

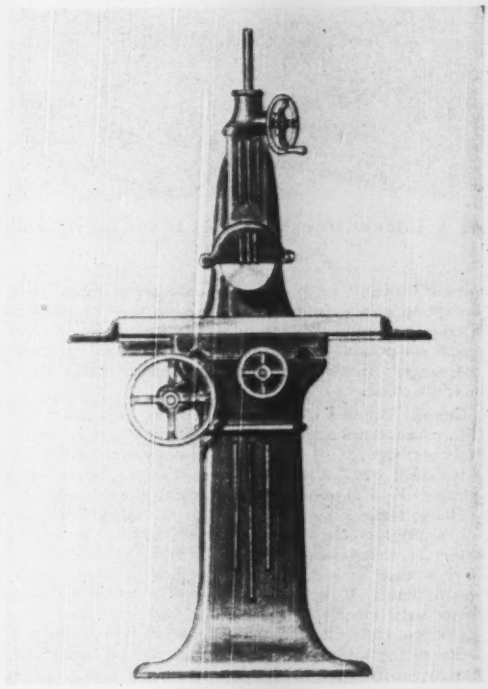

FIG. 1 AFTERTHOUGHT ORNAMENTATION DRAPED ON AN EXISTING DESIGN FAILS TO SUGGEST HIGH QUALITY

[1] Stylist.

[2] Assistant to Director of Design. Mem. ASME.

Contributed by the Machine Design Division and presented at the Fall Meeting, Worcester, Mass., September 20, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

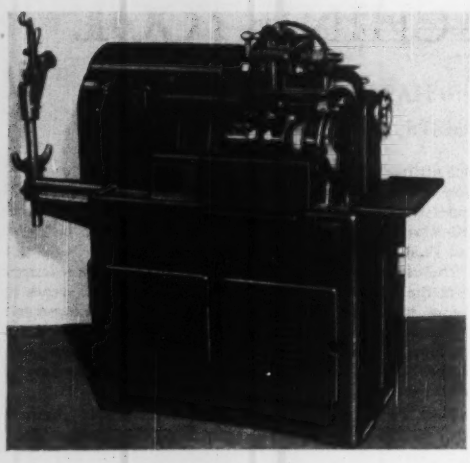

FIG. 2 FABRICATED STEEL BASE ON AUTOMATIC PINION-TURNING MACHINE

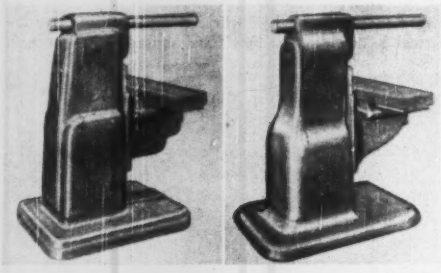

FIG. 3 LARGE RADII CAN GIVE A BLOCK AN UNPLEASANT, BULBOUS APPEARANCE

fabricated parts. In an effort to avoid sharp corners, designers are apt to go too far and with generous radii change a distinctive modern design into a bulbous mass. Fig. 3 gives a simple comparison of a machine stand with two sizes of radius and suggests that the design using the small radius has the more character.

Corners. Die and tool charges must be kept low for machines manufactured in small lots. Since spherical corners or areas of compound curvature cannot be fabricated without dies it is well to avoid such corners. Fig. 4 shows possible designs where cylindrical rather than spherical forms are used.

Hiding Under a Bushel. Although the block form is useful, a designer must guard against the trend to wrap everything in rectangular packages. From long association we have learned to identify many machine members with a specific form. It is poor design to hide these well-known forms under a box. So hidden, distinctive functional mechanisms lose their identity and take on a monotonous similarity to too many products of industry. An electric motor has an easily recognized cylindrical form which through the years has evolved from the economical use of metal. Why wrap the motor up in a box or hide it under a bushel? It has a familiar, pleasing appearance; let it stand out and be recognized. In Fig. 5 a headstock makes no attempt to hide its brake motor and gains a little character by its forthrightness.

Another familiar unit in toolrooms is the dividing head, Fig. 6. The head has a characteristic appearance, and a glance suggests the movements of which it is capable. Making a block of the dividing head would disguise its functions and add another "contents unknown" package to the machine.

Although the block form can be used effectively on machine tools it should be used with restraint. Keep in mind that people do not want a coffeepot to look like a teapot, and that trouble follows when the salt shaker looks like the pepper shaker.

Flutes and Ribs. The beds and bases, columns and uprights of machine tools are generally made of cast iron, and thus good casting practices dictate many of the rules of styling. Flutes or ribs are not very practical in large castings. An excessive amount of time is used in correcting or replacing them when they are distorted or lost in casting. Large castings are not scrapped just because an ornamental flute is imperfect. To avoid salvage work leave flutes and ribs off the large machine castings.

If ribs or flutes are to be used, they should be applied to the smaller or secondary units rather than to the main castings. On covers, plates, and doors, ribs are less likely to be deformed when molded and, if defective, the pieces can be replaced without serious loss. Ribs, especially when done in a contrasting finish, are distinctive, dignified, and in keeping with the geometric forms used on machine tools. However, it is suggested that ribs be used only if they make a positive contribution to the appearance of a machine. By making two illustrations, one with and one without ribs, a designer can usually make a decision. If it seems hard to decide—leave off the ribs.

Flush-Type Covers. The designer will find little need for ribs and flutes if he has taken advantage of functional members of the machine as a means of providing interesting visual appeal. There is little logic in using flush-type covers or compartment doors throughout the machine, with all the additional ex-

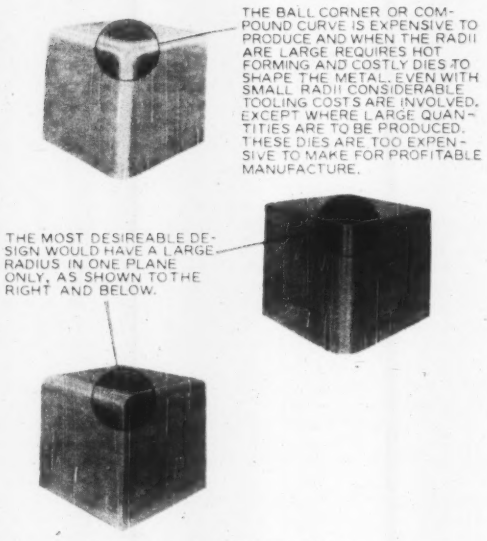
THE BALL CORNER OR COMPOUND CURVE IS EXPENSIVE TO PRODUCE AND WHEN THE RADII ARE LARGE REQUIRES HOT FORMING AND COSTLY DIES TO SHAPE THE METAL. EVEN WITH SMALL RADII CONSIDERABLE TOOLING COSTS ARE INVOLVED, EXCEPT WHERE LARGE QUANTITIES ARE TO BE PRODUCED. THESE DIES ARE TOO EXPENSIVE TO MAKE FOR PROFITABLE MANUFACTURE.
THE MOST DESIREABLE DESIGN WOULD HAVE A LARGE RADIUS IN ONE PLANE ONLY, AS SHOWN TO THE RIGHT AND BELOW.

FIG. 4 FABRICATED CORNERS

pense of manufacture and assembly, only to embellish them or other parts of the product with "speed lines" to retrieve some of the character which was so deliberately suppressed. Ease of cleaning may justify the smooth unbroken surfaces obtained with flush-type covers but easy cleaning will not support the use of flutes or protruding decorations. Fig. 7 suggests that a large surface can be improved in appearance by getting away from flush-type covers.

Expansive, unbroken, flat surfaces detract from the appearance of a machine. Since flush-type covers often make large flat areas possible, they are not helpful in styling a machine. In general, a designer should try to break up large flat surfaces. A broad band or panel elevated or relieved, relative to the normal level of the surface, will improve conditions and will also assist in camouflaging any unsightly irregularities which appear in castings and which cannot be hidden by filling and painting, Fig. 8. It is also possible to avoid flat areas by letting the encasement follow more intimately the enclosed mechanism, neither pursuing function too closely nor departing too far from it.

Matching Castings. In the drive to get smooth surfaces, designers often call for matched castings so that the surfaces of two adjacent castings will appear as one. Here the designer must face up to rough reality. In practice the surfaces will not blend or match, and it is necessary to accept a noticeable and uneven intersection, or pay the serious costs of chipping and grinding. It is a much more practical approach to design to call for a deliberate step or break where castings meet. Casting variations will vary the height of the step but

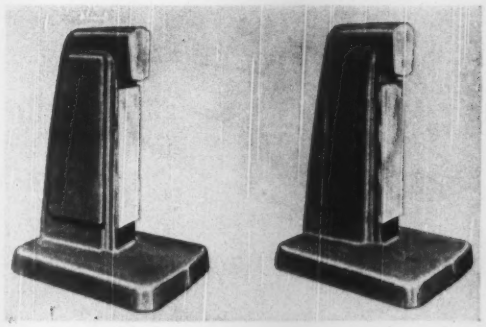

FIG. 7 FLUSH COVERS ARE COSTLY AND OFTEN HURT APPEARANCE BY CREATING LARGE FLAT SURFACES

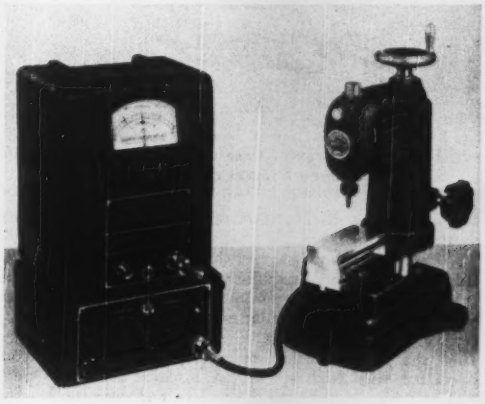

FIG. 8 BANDS ELEVATED FROM NORMAL SURFACES ADD INTEREST TO THESE CAST INSTRUMENT HOUSINGS

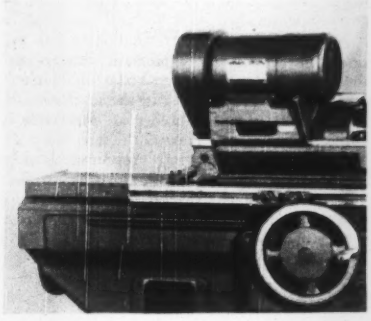

FIG. 5 LET A MOTOR LOOK LIKE A MOTOR AS IT DOES ON THIS GRINDING-MACHINE HEADSTOCK

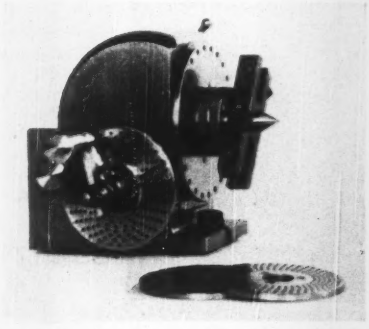

FIG. 6 FUNCTION DICTATED THIS FORM FOR THE DIVIDING HEAD

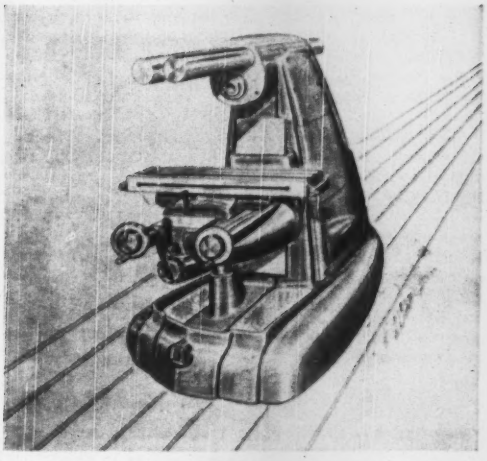

FIG. 9 MISAPPLIED STREAMLINING

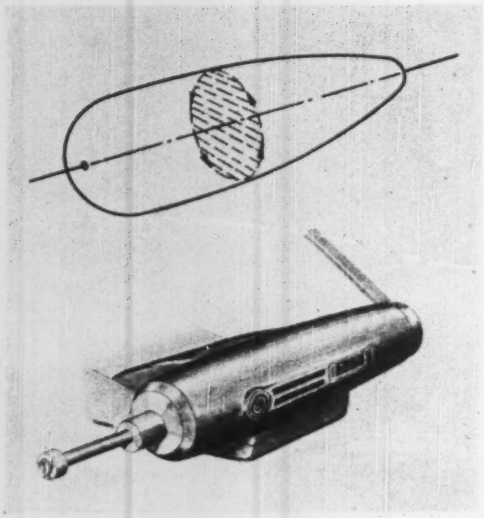

FIG. 10 THE STREAMLINE SWEEP OF THIS INTERNAL GRINDING ATTACHMENT HOUSING GIVES THE ASSOCIATION OF SPEED

will not have a glaring effect on appearance, nor will they require added or corrective machining.

Streamlining. Having agreed that function is of first importance in the design of machine tools and having been trained as engineers to know the purpose of streamline forms, we have little temptation to streamline machine tools. The purpose of getting streamline flow is to reduce resistance to motion. Thus the forms which best accomplish this have become associated with high speeds. A machine tool stays put—is often anchored to a floor of concrete, and there is no reason, Fig. 9, why capabilities of high speed should be suggested.

Occasionally one of the units on a machine tool can make valid use of streamline forms. Such a unit is the high-speed internal-grinding attachment, Fig. 10. The nacelle or housing can be streamlined gracefully, and the suggestion of high speed is appropriate, although the movement is rotation rather than translation.

Flat Pads. One of the most aggravating sights in machine tools is the appearance of bosses or recesses framing each and every screw used to fasten auxiliary parts to the machine frame. There seems to be a common belief that holes cannot be drilled into a surface unless the axis of the hole is absolutely perpendicular to the surface. Even the slightest angle or curvature of surface will provoke the use of a flat pad, elevated or depressed beyond the normal surface, as though the screwhead were something sacred, to be pointed out as the most important member of the machine. Fig. 11 shows the unpleasant outline of an irregularly shaped pad on the outer surface of a cover.

The engineer might also be warned to be aware of the spotty appearance resulting from numerous individual pads and bosses. For example, the bosses and pads shown in Fig. 12 might just as well have been made into one.

Name Plates. Nearly every machine carries some sort of name plate or identification. It also calls for other plates with instructions for operation, patent-number plates, and much other data. Some of these markings must be made visible. They can be treated to fulfill their intended function and at the same time become an attractive accessory, instead of being a necessary evil. No portion of the machine should be converted into a signboard. The manufacturer's name should be located prominently and by itself, and not forced to share attention with a long address or with a list of patent numbers.

CONCLUSION

Machine tools offer considerable resistance to the designer and cannot be considered ideal material in which to express his artistic feelings. The styling of the machine can never be expected to instill in the beholder an insatiable desire for possession. However, there is no reason why a machine should appear awkward or ugly. Appearance can be made a natural or basic part of the machine and can contribute quietly in the presentation of the machine as a precision product, a master tool created to do an exacting job quickly. Let appearance help to portray function.

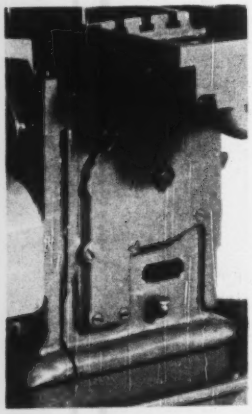

FIG. 11 PADS CAN GIVE AN UNWANTED EMPHASIS ON SCREWS AND FASTENINGS

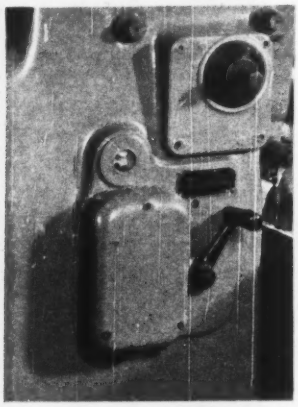

FIG. 12 SPOTTY APPEARANCE IS OBTAINED FROM ADJACENT BUT SEPARATE PADS AND BOSSES

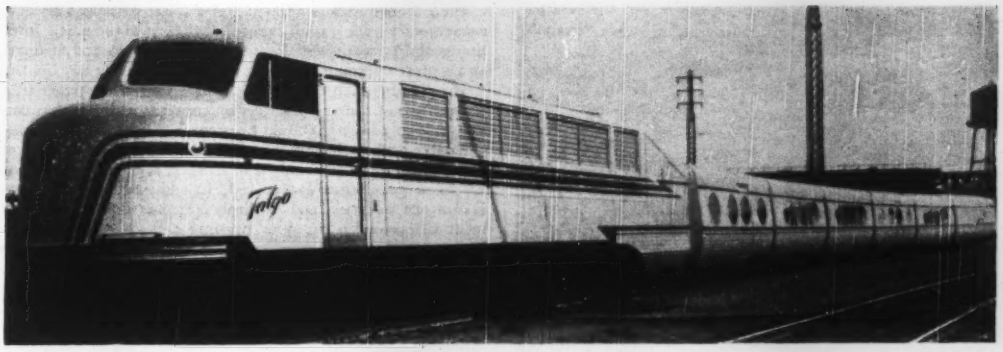

FIG. 1 COMPLETED TALGO TRAIN CONSISTS OF A DIESEL-ELECTRIC LOCOMOTIVE, A BAGGAGE UNIT, A COACH OF FOUR PASSENGER UNITS, AND AN EQUIPMENT UNIT

THE *Talgo* TRAIN

By J. M. GRUITCH[1] AND O. H. PHILIPS[2]

THE first train to be built in America, based on the Spanish "Patentes-Talgo" idea, Fig. 1, has been completed by the American Car and Foundry Company. One unit is for testing and demonstration in America and two complete trains and an extra locomotive will be put in service in Spain between Madrid and the French Border, a distance of approximately 400 miles. This will connect with de luxe express service to and from Paris.

The name "Talgo" is derived from the following Spanish words and names: Tren (train), articulado (jointed), ligero (light), Goicoechea (the inventor), Oriol (backers of the project).

The ACF-Talgo train evolved from the idea that useless mass was not needed to hold a train to the rails. This useless dead weight could be eliminated and give greater speeds on grades as well as greater economy of operation. The application of the steered principle would result in higher speed through curves and greater passenger comfort due to a much improved ride.

The steered principle which is the basis of Goicoechea's design can be compared to a trailer truck having a three-point geometry. Two points are the trailing wheels and one the steering and pulling coupler.

In conventional passenger equipment, the entire truck is free to rotate on the center plate of the car and, in taking a curve, the flanges of the leading wheels dig into the rail, tending to climb the rail. This is called the positive angle of attack. This is opposed by the mass of the car which keeps the trucks on the rail and guides the car around a curve.

In the Talgo principle, the ratio of the length of the train to the track gage is held to a proportion which assures that, in curves, the trailing flange of the wheel contacts the outer rail which holds the wheels down and reduces sharply the tendency to derail the train. This is called the negative angle of approach. Mathematically, the optimum lengths of cars to preserve this principle have worked to 20 to 30 ft for the U. S. and Spanish track gages, curves, and speed desired.

The two-wheel suspension which permits reduced weight reflects considerable savings in construction and operation. The weight reduction made possible by this theory results in a startling reduction in the size of the motive power necessary and produces an initial cost saving, great fuel economy, and lower maintenance cost, all of which are necessary to provide low-cost transportation.

DESIGN

The main problems in design were to preserve all the basic principles of the original idea and, in addition, meet all strength requirements commonly expected on American railroads. In addition, it was desired to pioneer new designs and to incorporate the latest equipment in heating, lighting, air conditioning, braking, and spring suspension that would insure passenger comfort.

To achieve this objective, extensive use was made of 17S-T, 24S-T, and 75S-T aluminum—thin, deep-pressed sections having strengthening and lightening holes drawn in at the neutral axis. All steel parts are alloy heat-treated to produce high strength with a minimum of weight.

To keep the units low and to afford ease of manufacture and maintenance, all equipment was moved from under units to an equipment car. To meet weight requirements, the designers were faced with the problem of providing an 8-ton-capacity air-conditioning system that weighed under 2000 lb. This was achieved by using a newly developed aluminum-cased compressor, aluminum coils, ducts, electronic controls, and compactness of design.

CONSTRUCTION

Essentially, the ACF-Talgo coach is built as three separate subassemblies which form the entire body. The underframe unit is shown in Fig. 2. This is built as a complete subas-

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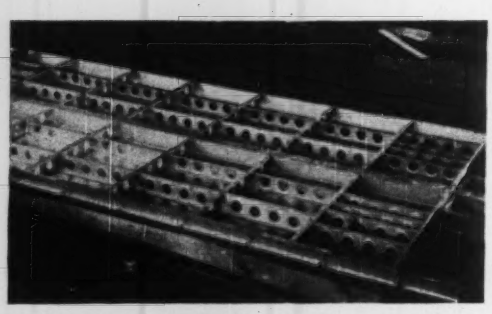

FIG. 2 UNDERFRAME UNIT OF ACF-TALGO COACH

FIG. 3 ENTIRE SIDE AND HALF OF ROOF SUBASSEMBLY OF COACH

sembly. It consists of a hat-shaped center sill which is a high-strength 75S-T aluminum-alloy extrusion. All cross-bearer members are hydropressed 24S-T Z-sections with lightening holes at the neutral axes. The edges of the holes are drawn out to give added strength and rigidity and to reduce possibility of fatigue failure at the edge of the punched holes. Side-sill sections are aluminum extrusions in the shape of an offset beam. The bottom floor is riveted to the entire structure, and the upper floor, which is $^1/_8$-in. plymetal, is fastened to all members by the use of blind rivets. This gives a completely boxed section which is light, rigid, and will absorb impact.

The subassembly which makes up the entire side and half of the roof is shown in Fig. 3. It, too, is built on a special jig so that a minimum of fitting will be necessary when the two side and roof halves are fitted to the underframe section.

The two end or bulkhead sections are deep hydropress sections, and it is this portion of the structure that transmits the load to the suspension system. Later, this is completely boxed to provide maximum strength with a minimum of weight. The intermediate sections are channel-shaped sections to the windows and hydropress sections above the windows. The openings near the center of the roof will carry the air-conditioning ducts.

Longitudinal members are also channel-shaped aluminum pressings except at the center of the roof which is a special aluminum extrusion.

The skin sheets, 24S-T aluminum, 0.051 in. thick, are used to carry stress and are drawn with $^3/_8$-in. beads to provide additional stiffness.

The running gear is applied last and all work can be done conveniently since it is all exposed at the end of the unit. Interchangeability was stressed and it kept handwork and fitting to an absolute minimum.

The simplicity in the construction is such a departure from present manufacturing practices on conventional cars that considerable cost savings should be effected.

Master brake cylinders afford easy repair and inspection, all air-conditioning equipment is in lockers, all electrical controls are on a panel in a locker and, in addition, a kitchenette, lavoratory facilities, and wardrobe are provided. The equipment car provides the door opening and all service for the two units ahead and two units behind. The equipment cars have bulkheads and doors, the coach units do not. Between units, protection is afforded by joining the cars with pressure-tight rubber diaphragms that join with zippers.

The Spanish train has a locomotive, a baggage unit, and 3 coaches or 17 units in all to carry 192 passengers. It will be 370 ft long and is for 5-ft 6-in. track gage while the demonstration unit is for standard American 4-ft $8^1/_2$ in. gage.

The floors of the car units are 2 ft 9 in. lower than modern streamlined equipment and the over-all height has been reduced 4 ft to 9 ft 6 in. over rail and yet headroom is more than adequate. The equipment weight per passenger has been reduced 75 per cent. The inside width of cars is $4^1/_2$ in. more than conventional cars because of the shorter length of individual units and therefore less overhang on curves.

Final weights of the ACF-Talgo unit are as follows: Locomotive, 135,000 lb; baggage unit, 6400 lb; coach unit, 6700 lb; equipment unit, 10,700 lb; and observation unit, 8300 lb.

The weight of the five units which handle the same number of people as a standard coach plus the equipment is only 37,500 lb whereas the average for lightweight conventional equipment is 130,000 lb.

The entrance to the equipment car is shown in Fig. 4. Note that from usual platform height, one easy step brings the passenger to floor level eliminating the high steps of the conventional train. It also provides a door not over 50 ft from any passenger, which is similar to conventional equipment.

Since there is no bulkhead between coach units, the passenger has an unrestricted view from equipment car to equipment car as shown in Fig. 5. The seats are aircraft-type seats of aluminum and magnesium with liberal amounts of sponge rubber. They are soft and restful and each double seat weighs only 51 lb and provides 42 in. of space between seats which is much more than provided in standard coaches. The illustra-

FIG. 4 ENTRANCE TO EQUIPMENT CAR

tion shows a coach and observation unit. The latter is fitted as a lounge.

The rear or wheel end of the ACF-Talgo coach is shown in Fig. 6. The coupler in the center provides longitudinal buff or draft only and is the steering point of the three-point principle. It is always kept over the center of the track because it is fixed between the wheels of the forward car. As the forward car goes into a curve, the front end of the following car is turned slightly to follow the center line of the tracks.

The pair of wheels and the drop axle are fixed to the body of the car through radius arms which are free vertically and laterally but keep the wheels and axle always perpendicular to the center line of the car. The drop axle also permits the floor to be moved down between the wheels which results in a lower center of gravity and lower over-all height.

All vertical load is taken by the load carry-through members. In curves, these slide in and out of rubber-mounted bushings mounted at the front of the trailing car. These points provide only vertical restraint, although they are fitted with snap-on safety collars which would become effective in the event of separation of coupler parts.

The axle is stationary with the wheels rotating independently This means that the one wheel does not have to skid around curves.

The spring of the vertical suspension system encloses a Monroe hydraulic shock absorber. The long spring gives a low natural frequency which reflects in a smoother ride and also permits bringing the suspension point above the center of gravity which is just under 40 in. from the rail

Fig. 7 shows the underside of the car. The car is centered between trucks by means of a torsion-spring bar-spring combination at *A* which runs under the floor and across the car. The front end is turned down to form a lever which is connected to the axle fitting by an arm. The lateral shock absorber *B* absorbs shock and prevents any tendency for the torsion bar to go into a frequency.

Also shown is the sway bar *C* similar to sway bars long in use in automotive work.

Having the suspension point above the center of gravity eliminates much of the tendency to roll in curves.

AAR AND TALGO LEAN-IN CURVES

In standard equipment, which has the weight of the car centered above the point where its weight is transferred to the truck and a center of gravity of 64 in., a car will tend to lean outward on a curve. This is compensated for by superelevation of the track.

FIG. 5 INTERIOR VIEW OF COACH UNITS

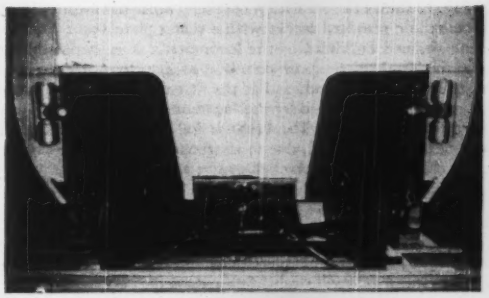

FIG. 6 REAR OR WHEEL-END OF COACH

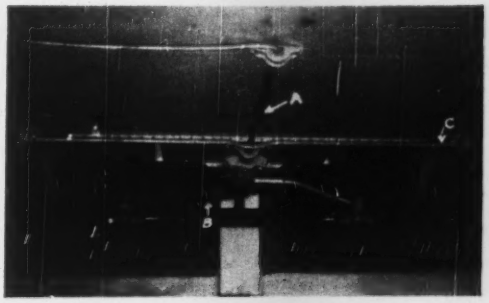

FIG. 7 UNDERSIDE OF COACH

The characteristics of the Talgo design: (1) the steered principle, (2) suspension of the car above the center of gravity, (3) low center of gravity, (4) lightweight (therefore lower centrifugal force), are such that the train will not lean out, but in, on a curve and will permit speeds through curves as much as 25 per cent faster than with present equipment without passenger discomfort or danger. In hilly sections of the country, running time would be reduced considerably. It would also cut down the need to brake sharply going into a curve and then accelerate coming out of curves.

LOCOMOTIVE

It was necessary for ACF to design and build a Diesel-electric unit for the train since the principles of the trailer units would be lost if a standard locomotive were used. Because the car weights were so low, lower horsepower was required, and to get the lightest engine of maximum horsepower, high-speed, supercharged, automotive-type Hercules Diesels were used.

As shown in Fig. 8 the locomotive contains two V-8 405-hp engines for generation of power for the truck motors, and since all electric-power requirements for the cars are drawn from the locomotive, two 6-cyl 170-hp auxiliary Diesel generators are placed in the locomotive. Fresh-water tanks and air compressors are also included. The locomotive is geared for 105 mph.

The structure of the locomotive is shown in Fig. 9. It is of low-alloy high-tensile steel, is all-welded, and the underframe is completely stress-relieved after welding. It is 2 ft lower in height than normal Diesel locomotives.

Operation is from one end only and operator's controls are the same as other standard Diesel engines.

Fig. 10 shows the transition coupler. Since the locomotive is mounted on standard trucks with a center plate about 6 ft 1 in. from the end bulkhead of the locomotive, it is impossible to use the same method of coupling as employed by the rest of the units. The front end of the first unit—usually the baggage unit—is supported by the locomotive, on this swing-link trapezoidal coupler. The beam is held parallel to the front of the baggage car and, due to its geometry, keeps the coupler over the center of the track the same as the other units.

WHEELS

The wheels are standard PCC type mounted in rubber.

In the wheel, axle, and brake assembly, there is no metal-to-metal contact of the rim to the other parts of the wheel. The load is taken through rubber sandwiches in shear.

Timken roller bearings are used in these wheels as well as the locomotive wheels.

A departure from standard railroad practice is the use of hydraulic internal expanding brakes. The old-type cast-iron brake shoes have many disadvantages which the industry has been trying to overcome for many years, and only recently other means of braking have been introduced in service.

It was found that a regular truck-type brake would give more than adequate braking without generating excessive heat.

The system is air over hydraulic, actuated from the cab simultaneously with the Westinghouse air-brake application on the locomotive. The air is carried through the units to the equipment car where the air pressure is transferred to hydraulic pressure in a Wagner Electric master cylinder. It is possible to check at any time the amount of brake-lining wear by observing the travel of the master cylinder during an application. An indicator is built into the cylinder for this purpose and air and hydraulic pressure gages furnish additional checks.

The brakes provide a smooth even stop in an emergency application, and stopping distances are shorter than on standard equipment.

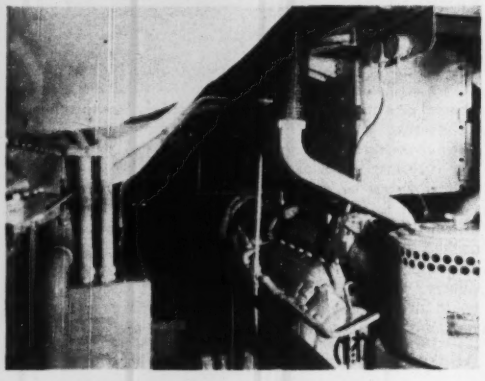

FIG. 8 INTERIOR OF LOCOMOTIVE SHOWING DIESEL INSTALLATIONS

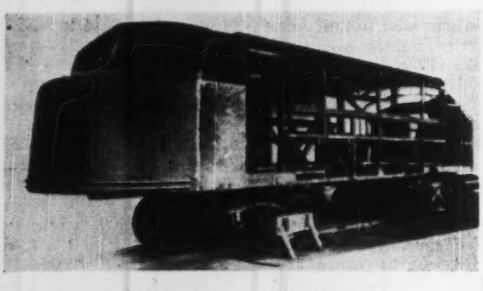

FIG. 9 VIEW OF LOCOMOTIVE STRUCTURE

TESTING

Testing was divided into three parts, static, simulated dynamic, and road testing. The baggage unit was tested first so that any changes necessary could be made before inside lining or wheels and axles were applied to the other units.

Stresses were checked with Baldwin strain gages and a Baldwin SR-4 indicator. Approximately 50 points in the structure were selected for gages and stresses were measured with varying loads up to 2g vertical. Loading was by means of sandbags. To get stresses of 1g lateral, the whole car was supported at the coupler and two load carry-through members, and turned over on its side, as shown in Fig. 11.

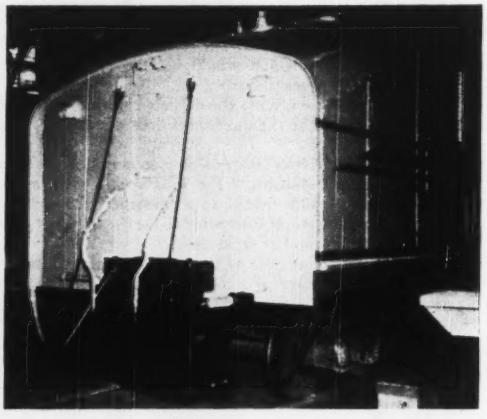

FIG. 10 TRANSITION-COUPLER END OF LOCOMOTIVE

To determine the reaction of wind load, a lateral force equal to 20 lb per ft of projected side area was applied by means of a spreader arrangement. Stresses as well as movements of the structure were obtained by this means. As a result of this test some changes were necessary in sway-bar size and attachment of shock struts. All stresses in body structure observed during these tests were well below design stresses and no change was necessary.

Center of gravity was determined by swinging the entire car on pendulums as shown in Fig. 12. This is the standard method and consists essentially of oscillating the car on two swings of different lengths. By the rates of oscillation, the known weights and heights, the centers of gravity can be computed. The Talgo baggage unit was found to have a center of gravity 38.7 in. over the rail, the coach units 39.3 in., and the equipment car 41.5 in.

A simulated dynamic test was conducted by building a machine with two rotating disks under the wheels as shown in Fig. 13. Disks were notched to simulate rail joints and controlled in speed. Various loadings were used and the action of the suspension system studied and stress readings taken.

The road tests were started as soon as three units were complete. The transition coupler was mounted on the back of a

flat car since the locomotive was not finished, and the train was composed of a steam locomotive, three standard coaches, the transition car, and three ACF-Talgo units. As additional units became available, they were put in the train.

Static testing of the locomotives included megging and hipotting all circuits, power rating all engines by waterbox, and checking all relays, thermostatic controls, operating controls, brakes, air, water, and fuel systems. After all were found in order, the locomotive was road-tested by itself.

During road tests, the baggage car was turned into an instrument room. In addition to the strain gages which were left in the units, accelerometers—six in all—were used throughout the train, giving longitudinal, lateral, and vertical accelerations in any two points at one time. Travel gages were attached to

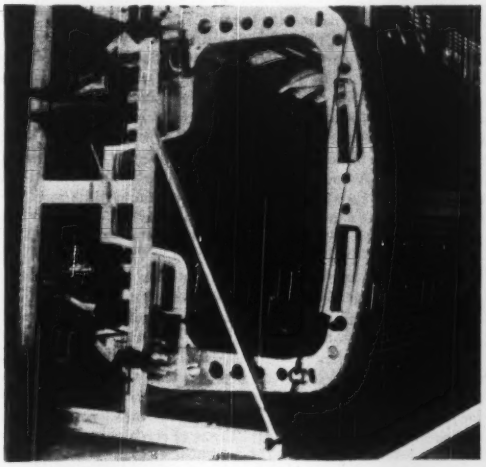

FIG. 11 CHECKING LATERAL STRESSES OF BAGGAGE CAR

various moving parts, and all this was recorded on photographic paper in oscillographs.

A camera was also located under one of the coaches and operated by remote control from the baggage unit. This gave a photographic record of the action of the wheels through curves, switches, and crossovers, and adequately proved that the negative-angle theory functions as described.

Many changes were made during testing, but thorough static and dynamic tests showed no changes were necessary to the primary structure or to parts that were not readily accessible.

The diaphragms were found to function properly for their intended purpose between cars; they flex as cars go into and out of curves and keep all water and dust out of the car. This was a wartime development by Goodrich used on tank turrets.

The demonstration train has operated over more than 5000 miles and, while a lot has been learned from the runs, more work will be done. Some evidence was also found indicating that balanced wheels will further smooth out the ride. In the Talgo train, this is probably more critical than in conventional equipment because of the lightweight of the body.

AIR CONDITIONING

Each equipment car has air-conditioning equipment of sufficient capacity to adequately heat, cool, or ventilate a complete coach of five units. Three-phase 50-cycle 208-volt power supply from the locomotive was used. Special totally enclosed sealed freon compressors and aluminum construction were employed wherever possible. Electric strip heaters were used instead of the usual steam heat. In cold weather, warm air is circulated through the ducts used for cooling in the summer.

Each equipment car has two 5-hp refrigeration compressors, one $1\frac{1}{2}$-hp evaporator blower motor, one $\frac{3}{4}$-hp condenser fan motor, one $\frac{1}{3}$-hp condenser pump motor. There are also 208-volt electric strip heaters wired to provide up to a total of 42.0 kw. Lighting is from the 120-volt circuit.

SUMMARY

The test runs have shown that the principles are correct and that considerable savings can be effected by the railroads. For the passenger, faster schedules can be expected with greater comfort and safety. Maintenance of equipment should be reduced because of the simplicity of design and lightweight which would not require heavy specialized handling equipment. Talgo parts should not wear as fast as conventional equipment because the load on parts is not excessive, and maintenance of roadbed and rails should be less.

The ACF-Talgo demonstration unit as designed is an all-coach train only because it matches the two for Spain. For the future, unit lengths could be adapted to make sleeping cars, lounge cars, diners, and commuter units. The fast freight for perishables as well as other L.C.L. shipments could use ACF-Talgo principle cars to advantage.

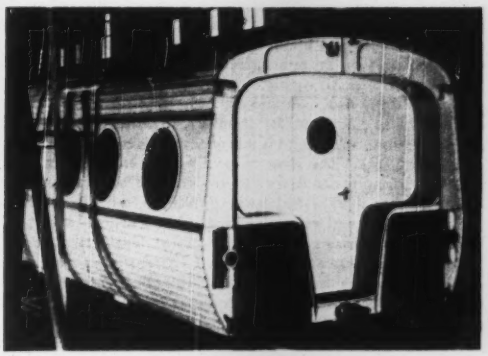

FIG. 12 DETERMINING CENTER OF GRAVITY OF CAR

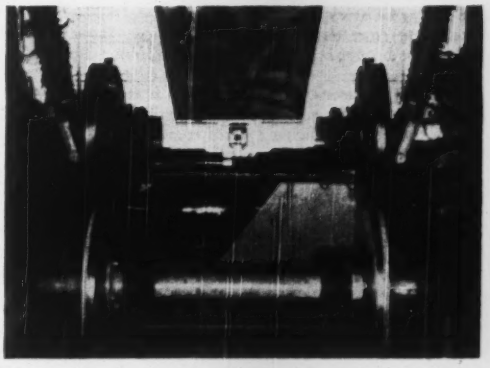

FIG. 13 DYNAMIC TEST SETUP

JOBS *for Young* MECHANICAL ENGINEERS

By J. I. REYNOLDS

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING, WEST VIRGINIA UNIVERSITY, MORGANTOWN, W. VA. MEMBER ASME

ALL through World War II and on up until the present time, it has been extremely easy for a mechanical-engineering graduate to obtain a job. Now we have reached the point where some difficulty in finding work will be experienced by engineering graduates. It is the author's purpose to advise new engineering graduates in ways of surmounting the difficulties.

JOB OPPORTUNITIES

It has been found that graduates of engineering schools, some few years after receiving their degrees, divide up about as follows in the types of work they are doing. Roughly, one third are in orthodox engineering jobs; another one third are in jobs that are closely allied to engineering such as purchasing, for instance; and the other third are in nonengineering work. If a young man has difficulty in getting into straight engineering work, he should cast about for employment chances in either the allied field or in nonengineering employment. Thus he greatly multiplies his opportunities for employment.

Nonengineering Jobs. Should the only job he can find be nonengineering in character, he should realize that a man with an engineering background is not wasting his training in a nonengineering job. The more mental agility and the more analytical ability one can devote to any class of work, the better he can do that work. Engineering training, with its emphasis on getting facts and arriving at logical conclusions with these facts as a basis, is as good a way as any of developing the ability to think quickly and accurately. Therefore a nonengineering job should be approached with the confidence that one's training will be a definite asset and that one is well-trained for that job.

If a young graduate is seeking a nonengineering job, either through choice or through necessity, he should be prepared to contend that his training for such jobs is as adequate as the training possessed by graduates of arts colleges. After all, the study of history is no more closely related to buying for a department store than the study of statics. However, both subjects do develop critical thinking which is useful in any kind of job.

Engineering Positions. If a young man is seeking one of the orthodox engineering positions, he should be ready to tell a prospective employer what type of engineering he would like to do as he is very apt to be asked that question. Engineering divides up into design, research, development, testing, construction, installation, production, servicing, sales, estimating, maintenance, and so forth. Before graduation, the student should get some information about these fields from one of his teachers. Then he should devote some time to selecting the field or fields for which he has the most aptitude and interest.

APPLICATION LETTERS PLUS PERSONAL CONTACTS

Letters of application to various firms should be sent out early in a student's last semester. These letters should be composed carefully and written neatly, preferably typed. A good form to follow consists of three divisions: (*a*) the position desired, (*b*) one's qualifications, including personal data, and (*c*) a statement of one's references.

Personal contacts usually bear more fruit than letters of application. The latter are filed away if nobody is needed at the moment. Later on, the need for a man may arise. If a candidate who can fill the need happens in at the time, he probably will get the job. The employer is able to make a much fuller appraisal of a man by personal interview than can be made from an application form. He is more apt to hire someone he has seen and talked with than he is to hire from the application files where the information is not so "alive." Because of the foregoing, a job seeker should prepare himself to tramp the streets looking for work. Sooner or later, he will happen into a place where he can be used and will be hired.

OPPORTUNITIES WITH SMALLER COMPANIES

Opportunities with large corporations and with the Government are rather limited today. For this reason, the young engineering graduate should look to the medium-sized and small companies for a job. Most of these companies do not send interviewers to college campuses. This sometimes means that they find it more difficult to get engineering personnel when such people are needed. This being the case, the recent graduate may be more apt to find the "welcome mat" at these companies than he is to find it at the doors of the large corporations.

Many small manufacturing businesses and concerns of a service nature have no engineers in their employ. This usually indicates that the managers are unaware of the advantages to them of having one or several engineers on their staffs. An engineer can probably give the company more aggressive plant maintenance than it enjoys at present. In the manufacturing end, after two or three years of acquainting himself with the product, the production machinery, and the plant methods, the young engineer should be able to improve the product, thus strengthening its market position and should be able to improve the production and assembly methods, thus reducing costs. In order to get the chance to do this, he must convince the small-plant owner that he possesses talents and training which equip him for this sort of work. If a young engineer will keep these considerations in mind, he will increase his chances of finding work. However, he must realize that obtaining a job where one does not now exist requires clever salesmanship.

POSSIBILITY OF DEVELOPING A BUSINESS

Every engineering graduate should consider the possibility of going into business for himself as this automatically solves the question of finding employment. He must be sure that he can manufacture a product that will find a ready market or render a service that will be in demand. He must also be certain that he can find the very necessary initial capital. He must be the type of fellow who will take calculated risks and who would far prefer being his own boss to working for someone else. In short, working for oneself is to be commended but is not to

(*Continued on page 798*)

SMOKE-DENSITY MEASUREMENT

Correlation of Solids Content in Gas With Photoelectric Smoke-Meter Readings[1]

By WILBERT F. STOECKER[2]

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INTRODUCTION

THE most common method of smoke measurement is by a visual comparison between the smoke issuing from a stack and a set of Ringelmann charts. Convenience is certainly the chief advantage of the Ringelmann method. After brief instructions, an inspector can use the Ringelmann technique with reasonable success. Observations can be made from outside the plant, and the only equipment required is the set of charts.

The inadequacies of this type of measurement have exposed it to constant criticism. The system is subjective and purely arbitrary so that two observers frequently fail to arrive at the same reading. The intensity of the sunlight, the wind velocity, and other atmospheric conditions affect the observation. No inspection can be made at night. Furthermore, dilution of the stack gases with air decreases the blackness of the smoke. The thickness of the smoke column (size of stack) and the temperature and velocity of the flue gas also have an effect upon the results.

Probably the most direct approach to finding the weight of solids discharged is by removing and weighing the particles from a measured amount of gas. The concentration of solids then can be expressed in weight per unit volume at a specified temperature. Although for field observation this filtration technique is not always practical, nevertheless it is the only means of making a quantitative determination, and hence was adopted for these tests.

A previous publication of the Illinois Geological Survey[3] has described the use of the photoelectric cell for determining smoke concentration based upon the relative opacity of the gas. However, no information was available in regard to the correlation of the opacity of the gas and the actual weight of the solids suspended in the gas. The purpose of these tests was, therefore, to study the factors which influence this correlation.

EQUIPMENT

A considerable part of the equipment used has been described in previous publications of the Illinois State Geological Survey.[4] The stoker-fired furnace with a rated output of 150,000 Btu per hr was used for all tests. In order to minimize the loss of solid particles from the gas stream prior to smoke measurement, the secondary heat-exchanger surface was bypassed, and the stack gases proceeded directly from the combustion chamber into the stack. The stoker incorporated an air control which maintained an approximately constant delivery of air for a given setting of the control. The rate of coal feed was about 20 lb per hr. For some tests it was found desirable to supplement the stoker feed with hand-firing in order to produce the desired amount of smoke. Smoke, in this report, refers to the solids released in combustion, both carbon and ash. Fig. 1 is a schematic drawing of the equipment.

The fuel used throughout the tests was Vermilion County,

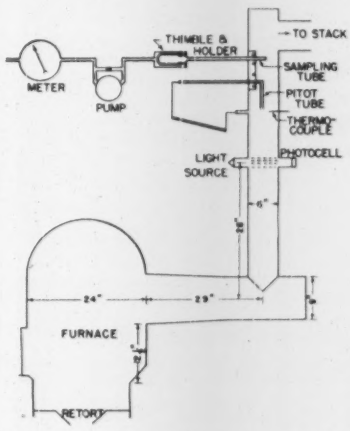

FIG. 1 SCHEMATIC DRAWING OF EQUIPMENT

No. 7 Seam coal obtained from Danville, Ill. The proximate analysis, as received, was as follows:

	Per cent
Moisture	12.0
Volatile matter	37.9
Fixed carbon	42.6
Ash	7.5

The higher heating value was 11,624 Btu per lb.

An alundum filter was used for collecting the samples for the tests. This filter was held in position by a steel thimble holder, Fig. 2. The thimble was tightened against the soft rubber gasket on the nozzle by screwing the nipple. Tightening the lock nut against the filter receptacle prevented loosening of the nipple by vibration during the tests. The sampling

[1] Published by permission of the Chief, Illinois State Geological Survey.

[2] Formerly Research Assistant, Illinois State Geological Survey, and Assistant in Mechanical Engineering at the University of Illinois.

[3] "Smoke Index: A Quantitative Measurement of Smoke," by R. J. Piersol, Illinois Geological Survey, Report of Investigations 41, 1936, 113 pp.

[4] "Correlation of Domestic Stoker Combustion With Laboratory Tests and Types of Fuels. II Combustion Tests and Preparation Studies of Representative Illinois Coals," by R. J. Helfinstine and C. C. Boley, Illinois Geological Survey Report of Inv. 120, 1946, 62 pp.

Contributed by the Process Industries and Fuels Divisions and presented at the Semi-Annual Meeting St. Louis, Mo., June 19–23, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Manuscript received at ASME Headquarters, February 27, 1950.

tube was inserted through an opening in the stack. After the test, the thimble holder was dismantled, and the sample remaining in the sampling tube was brushed into the thimble to be weighed with the collected sample.

A sample of gas was drawn from the stack and through the filter by a vacuum pump and measured by a wet-test meter. The rate of sampling was controlled so that the velocity of the gas into the sampling tube was equal to that of the gas flowing in the stack.

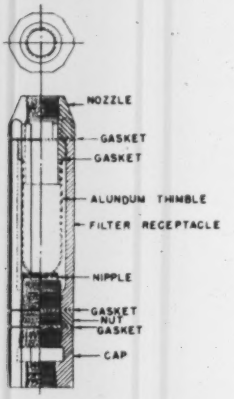

FIG. 2 THIMBLE HOLDER

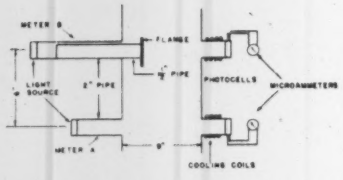

FIG. 4 VARIABLE SMOKE-COLUMN-THICKNESS TEST APPARATUS

The elements of the smoke meter consisted of a light source, a photoelectric cell which converted light energy into electrical energy, and a mounting to hold the light source and photocell in position. A feature of the meter assembly, which was devised by Roy J. Helfinstine of the Illinois Geological Survey and is illustrated in Fig. 3, was the ability to check the zero reading even while a test was in progress. The light and photocell could be pivoted as a unit from the working position in which the beam of light passes through a pipe, free from smoke, onto the photocell. A microammeter, with a zero to 100 range, indicated the current output of the photocell.

In order to study the effect of the thickness of smoke column through which the light shines, it was necessary to make simultaneous determinations of the light absorption by a given smoke density, but with different smoke-column thicknesses. Two smoke meters, A and B, were installed in a 9-in. smoke pipe. Meter A was fixed in position to measure the 9-in. column as shown in Fig. 4. Inside of the light source side of smoke meter B was inserted a $1^1/_2$-in. pipe which could slide freely in the 2-in. coupling. In order to prevent the $1^1/_2$-in. pipe which was extended in the gas stream from deflecting the gas and smoke into the path of the beam, a flange which served as a vane, was attached to the end of the telescoping pipe. The flange also made certain that all light reaching the photocell passed through the interior of the telescoping pipe and not around the outside.

To study the effect of the composition of suspended solids upon their light-absorption characteristics, prepared samples were agitated in a rotating cylindrical drum, Fig. 5. Flanges which extended $^1/_2$ in. from the walls were fastened at the four quadrants of the cylinder. The ends of the tumbler were tapered to deflect the particles back into the cylindrical portion. Soot and fly ash mixed in varying proportions from 100 per cent soot to 100 per cent fly ash were utilized to study the effect of composition. The light source and photocell were mounted at opposite ends of the tumbler. Electrical contact was made by sliding brushes on bands which were insulated from the metal tumbler.

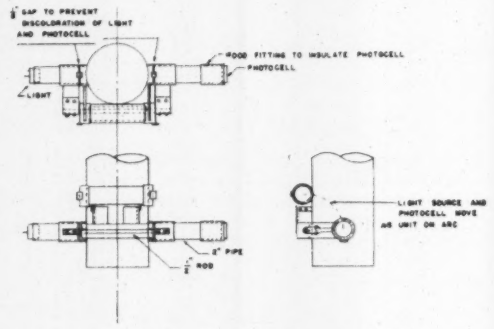

FIG. 3 SMOKE-METER ASSEMBLY

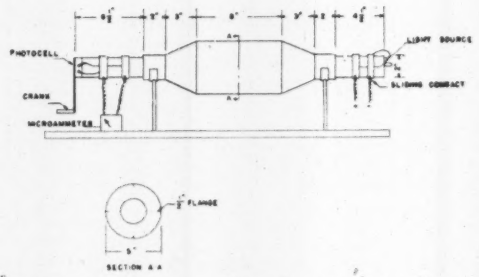

FIG. 5 TUMBLER USED FOR "EFFECT OF COMPOSITION TESTS"

TEST PROCEDURE

An iron-constantan thermocouple was inserted into the center of the smoke pipe for the determination of the stack temperature. The velocity of the stack gases was measured by means of a Pitot tube. A traverse showed that the velocity at the center of the stack was the approximate mean velocity. While a test was in progress, the velocity and temperature of the gas were checked every minute, and the rate of sampling was adjusted, when necessary, to maintain the velocity of the gas into the sampling tube equal to that of the gas flowing in the stack.

The weight of solids was determined by weighing the alundum filter before and after each test on an analytical balance. Since heavy smoke concentrations could not be obtained with normal stoker operation, coal was placed on top of the hot fuel

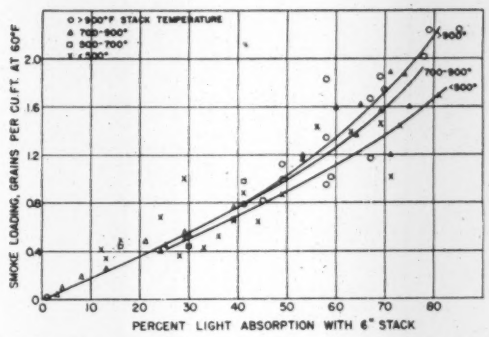

FIG. 6 GRAINS PER CUBIC FOOT AT 60 F VERSUS LIGHT ABSORPTION

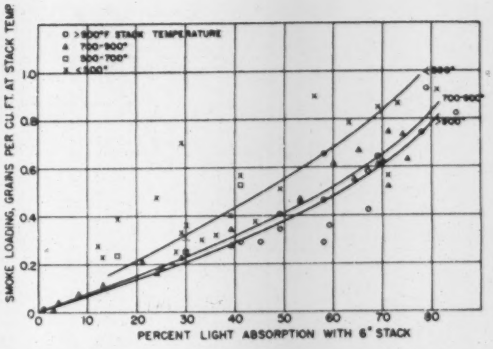

FIG. 7 GRAINS PER CUBIC FOOT AT STACK TEMPERATURE VERSUS LIGHT ABSORPTION

bed whenever dense smoke was desired. If the smoke density was greater than desired, secondary air was admitted at the center of the firing door. This secondary air entered too far above the combustion zone to affect the combustion reactions, hence the smoke reduction was due to dilution rather than to improved combustion.

RESULTS

Filter Efficiency. Since one of the important measurements in the tests was the weight of soot and fly ash in a volume of gas, the accuracy of this value was dependent upon the efficiency of filtration by the alundum thimbles. For the purpose of calibration, therefore, a special test was made in which the gas was passed through two filters in series after it passed through the alundum thimble. The average efficiencies of four thimbles in twenty-four tests was approximately 96 per cent.

Correlation of Photocell Readings and Filtration Results. The smoke loading in grains per cubic foot at 60 F was plotted against the per cent light absorption in Fig. 6. The points are represented by a symbol depending upon the average stack-gas temperature during the test. There appears to be a slightly different curve for each temperature range with the higher temperatures showing a smaller percentage of light absorption for the same smoke loading. Part of this temperature effect can be expected, for, if the ratio of weight of smoke particles to weight of gas remains constant, a higher temperature will cause an expansion of the gas and will result in a lower concentration of particles. However, when the smoke loading in grains per cubic foot of gas at the actual stack temperature was plotted against the per cent light absorption, as shown in Fig. 7, the curves representing the temperature ranges above 500 F were fairly close to one another, but the curve for the points representing lower than 500 F temperatures deviated from the other curves more than the corresponding curves in Fig. 6. The fact that the curve in Fig. 7, labeled 500 F, did not coincide with that for the higher temperature indicated that factors other than the expansion and contraction of the gas may be present. There is a possibility that the texture and composition of the smoke particles are dependent also upon the temperature.

The data shown in Figs. 6 and 7 can be analyzed by means of Lambert's law which is the theoretical expression for light absorption when a beam is passed through a suspension of solids of uniform size, density, and opacity.

$$I = I_o e^{-kx}$$

where

I_o = original light intensity
I = intensity after passing through thickness x
k = material absorption coefficient

$$\ln \frac{I_o}{I} = kx \quad \text{(by conversion)}$$

If the x-term is used to represent the concentration of solid particles, the graph of $\ln I_o/I$ against x should show a straight line of slope k if the assumptions are correct. In the semilog plot, Fig. 8, the curve becomes more steep in the dense-smoke regions. The absorption of light in these regions, then, is greater than that expressed by the equation. A greater percentage of carbon in the dense smoke, Fig. 15, may explain this deviation, since carbon absorbs more light for a given weight than does ash.

Variable-Thickness Smoke-Column Tests. Previous demonstrations have shown that the thickness of smoke column influences

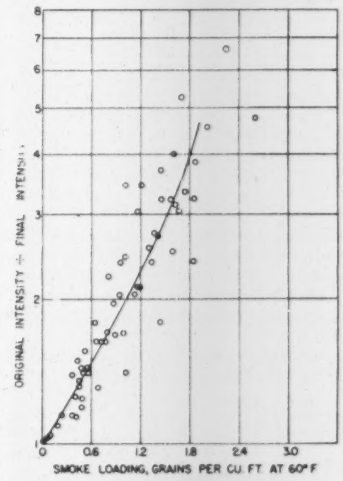

FIG. 8 ORIGINAL INTENSITY ÷ FINAL INTENSITY VERSUS SMOKE LOADING

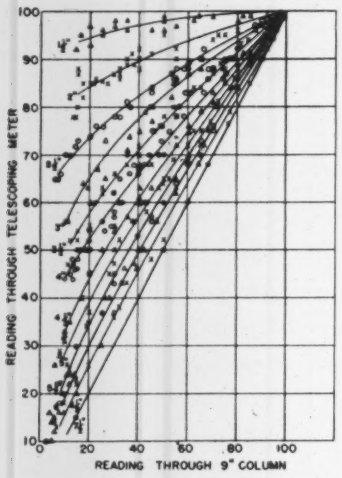

FIG. 9 READING THROUGH TELESCOPING METER AND THROUGH 9-IN. COLUMN

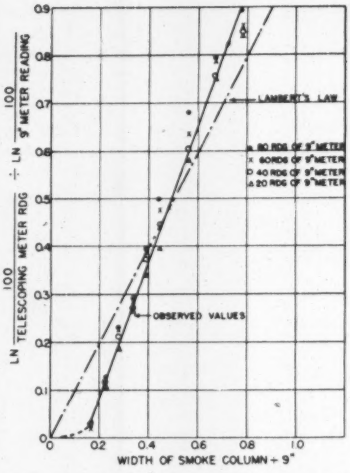

FIG. 10 RELATION BETWEEN TWO METER READINGS AND THICKNESS OF COLUMN

the opacity of the stream.[5] In the tests reported in this paper, when the readings in microamperes of the telescoping meter were plotted against the simultaneous reading of the 9-in. column meter, as shown in Fig. 9, a family of curves represents the results. A reading of 100 microamperes represents a clear stack. As the width of the column, measured by the telescoping meter became thicker, the curves approached a straight line showing equal readings of the $7\frac{1}{2}$-in-column telescoping meter and the 9-in-column meter. No deviation from this straight line is expected when the telescoping-meter column is increased from $7\frac{1}{2}$ in. to 9 in., indicating a certain lack of critical definition when the columns are of approximately the same thickness. As the smoke column decreases in thickness, the curves become progressively more horizontal in the light-smoke regions and theoretically drop to the origin of the dense-smoke region.

With the total air supply and stack temperature known, Figs. 6 and 9 may be used to calculate the total weight of solids discharged from a stack. If the weight discharge is to be determined from a 4-in. stack when the meter reading is 80 microamperes, for example, a vertical line between the 4-in. and the 6-in. curves in Fig. 9 shows that a 6-in. column of the same-density smoke would give a reading of 70 microamperes. Referring to Fig. 6, if the temperature is in the 700–900 F range, 100 minus 70 microamperes or 30 per cent light absorption indicates a smoke loading of 0.55 grains per cu ft. By multiplying the loading by the flow of flue gas in cubic feet per minute corrected to 60 F, the weight discharge of solids is found. Data were taken only for columns less than 9 in. diam; however, the method would apply equally well to large-size stacks.

From Lambert's law a relationship is obtained between the two meter readings and the thickness of column as follows:

$$\frac{\ln\left(\frac{100}{\text{Telescoping-meter reading}}\right)}{\ln\left(\frac{100}{\text{9 in. meter reading}}\right)} = \frac{\text{Width of variable smoke column}}{9}$$

[5] "Inadequacy of the Ringelmann Chart," by L. S. Marks, MECHANICAL ENGINEERING, vol. 59, 1937, pp. 681–685.

If this expression is borne out by the experimental data, the left-hand side of the equation plotted against the right-hand side should show a straight line of slope 1.0. The readings for the telescoping meter were obtained from the curves in Fig. 9, at 9-in. meter readings of 80, 60, 40, and 20, respectively. The plotted points in Fig. 10 give a straight-line relationship, but the slope is greater than 1.0. If the straight line were extrapolated, it would indicate that the telescoping meter would read 100 while light was still shining through a 1-in. thickness of smoke. Extrapolation of the other end of the line would show that the two meters would give the same reading even though the light for the telescoping meter was shining through only 8 in. of smoke. No convincing explanation could be found for this deviation from the theoretical.

Photomicrographs. For the purpose of making microscopic examinations of the smoke, specimens were taken by inserting slides into the stack. No adhesive coating was necessary in order to retain the sample on the slide. The length of time to secure an adequate deposit varied from a few seconds in dense smoke to 20 to 30 sec in light smoke. The samples were largely carbon particles.

Comparison of the photograph of light smoke (10 per cent light absorption with a 6-in. column), Fig. 11, with that of dense smoke (60 per cent light absorption), Fig. 12, shows little difference in particle size The distance between each of the small divisions of the grid in the center of the photograph is 3 microns. The size of most of the particles is about 1 micron and under. The blurred particles at the borders of the pictures appear largely due to photographic distortion. In dense smoke occasional masses of soot occur which are clusters of the smaller particles. The particles adhere to one another upon contact, making these clusters more probable in the heavier smoke concentrations. The number of particles is dependent upon the length of time the slide was exposed to the smoke.

Whenever one of the clusters intercepts the beam of light of the smoke meter, the light absorption is less than it would be if the particles were finely divided. This is because a particle in the shadow of another can absorb only the light which passes through the first particle. When the particles are clustered it is more probable that some will be in the shadow

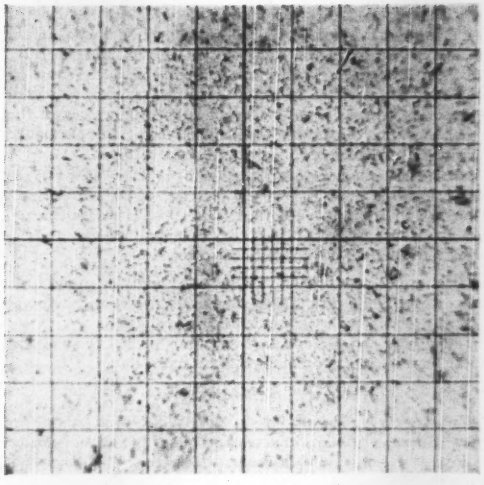

FIG. 11 LIGHT SMOKE; 10 PER CENT LIGHT ABSORPTION

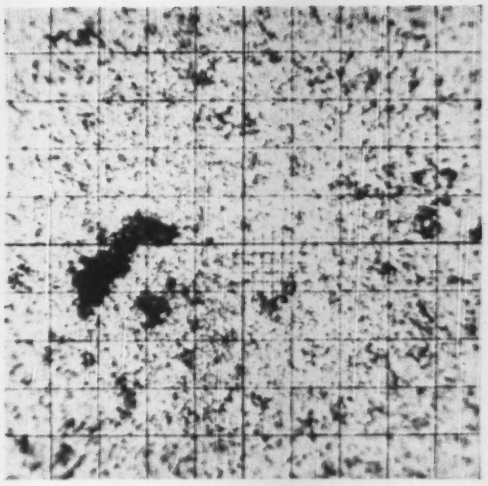

FIG. 12 DENSE SMOKE; 60 PER CENT LIGHT ABSORPTION

of others than if they were separated. If this effect were prominent, the curve of

$$\ln\left(\frac{\text{Original light intensity}}{\text{Intensity of light after absorption}}\right)$$

plotting against the smoke loading, Fig. 8, would deviate downward from a straight line in the dense-smoke region. The curve, however, shows no such trend. This probably indicates that each individual particle absorbs such a small percentage of the light and that the light passes through so many aligned particles in the stack, that the clusters have little effect upon the total light absorption.

Flue-Gas Analysis. The composition of the gas plotted against the smoke loading, Fig. 13, gave erratic results in the case of CO_2 and O_2. The carbon-monoxide concentration increased uniformly with the increase of smoke. This trend was also found by other investigators.[6] The data from this series of tests must be viewed with the realization that they were not obtained with normal stoker operation. Dense smoke was obtained by pouring green coal on the top of the hot fuel bed. Coal was added when necessary to maintain the desired smoke-meter reading. To decrease the amount of smoke, secondary air was introduced through a port in the fire door. The conditions were more nearly representative of poor hand-firing operation immediately following the addition of fuel.

At the point where the smoke loading was 1.2 grains per cu ft for which the CO concentration was 2.0 per cent and CO_2 was 12.4 per cent, the heat loss due to incomplete combustion of CO was 9.7 per cent. The heat loss due to solids (assumed to be carbon) in the flue gas was 3.5 per cent. Emphasis placed on the fuel saving by elimination of solids alone seems unwarranted, whereas the saving by completely burning CO would be appreciable.

Effect of Composition. The tumbler used for this series of tests provided good agitation, although it is not known whether the carbon and ash were always mixed uniformly. The influence of the composition of the solids in the stack gases upon the light absorption is shown in Fig. 14. Mixtures high in carbon content absorbed a greater percentage of the light than did those high in ash. The low-ash samples also were the least dense. For example, the sample containing 6.93 per cent ash occupied about 3 times the volume of the 98.9 per cent ash sample. No density determination was attempted because the density of the carbon depended upon the degree of packing.

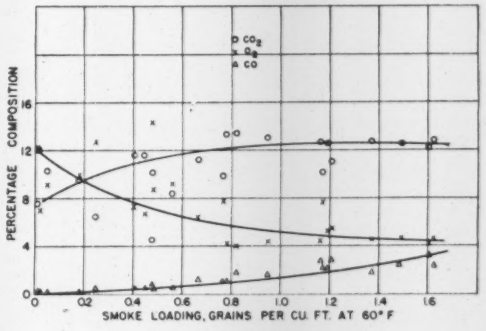

FIG. 13 COMPOSITION OF GAS

It should be pointed out that the size of particles used in the tumbler tests was larger than encountered in smoke. Also, the ash particles were generally larger than the carbon particles, which fact contributes to the change in light-absorption characteristics. Small, finely divided particles do not transmit as much light as large particles for a given concentration in the gas.

When the weight of smoke discharge, based upon light absorption, is desired, it is apparent that the percentage of ash must be considered. Although the highest ash content in the smoke from the stoker during this series of tests was only about 5 per cent, as shown in Fig. 15, operating in a more normal manner or by using coal with a large proportion of fines or pul-

[6] "Smoke," by W. T. Cosby, British Coal Utilization and Research Association, Bimonthly Bulletin, vol. 13, July, 1949.

verized coal undoubtedly would give higher ash content.

Ash Analysis. When an ash analysis was made of the filtered solids, and the percentage of ash was plotted against the per cent light absorption as shown in Fig. 15, a trend was indicated. The ash content is lower in dense smoke than in light smoke. The smoky conditions usually were obtained with a low air supply. An increase of air generally will cause more fly ash. The dense smoke is caused by the excessive amounts

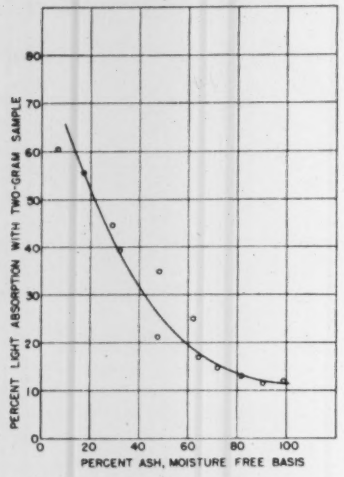

FIG. 14 INFLUENCE OF COMPOSITION OF SOLIDS UPON LIGHT ABSORPTION

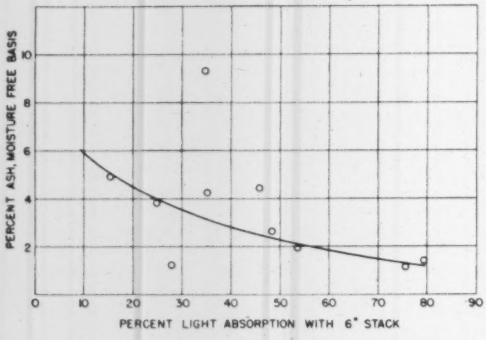

FIG. 15 PER CENT ASH AT VARIOUS SMOKE DENSITIES

of carbon, and under these conditions the weight of ash makes up only a small percentage of the mixture.

CONCLUSIONS

A correlation was found between photoelectric-cell readings and the weight concentration of smoke as determined by a filtration process.

Factors which must be considered in converting a photoelectric determination to a basis of weight per unit volume are as follows:

1 The temperature of the gases at the point where the photocell is installed.

2 The thickness of the column. Since the tests were limited to a maximum stack size of 9 in. diam, additional data should be obtained for larger-size stacks. For a given smoke density, the light absorption by the smoke being measured must be converted to a light-absorption value with some standard thickness of smoke column. Light-absorption values of the standard column thickness must be calibrated against the smoke concentration expressed in weight per unit volume.

3 The percentage of ash in the solid particles. For a given smoke loading in the stack, the presence of fly ash causes a reduction in the light absorbed. For precise measurements, each installation would have to be calibrated because of variations in the fuel and methods of firing the fuel.

Microscopic examination of the smoke particles showed the size to be fairly uniform. In the dense concentrations there was a greater tendency for the particles to form clusters.

The increase in smoke density was accompanied by an almost linear increase in carbon-monoxide concentration.

ACKNOWLEDGMENTS

This work was performed in the Applied Research Laboratory of the Illinois Geological Survey and under the administration of Roy J. Helfinstine, Mechanical Engineer. This report is a summary of a thesis submitted in partial fulfillment of the requirements for a degree of Master of Science in Mechanical Engineering and carried on under the supervision of S. Konzo, Professor of Mechanical Engineering, University of Illinois.

Jobs for Young Mechanical Engineers

(Continued from page 792)

be entered upon without a considerable amount of careful reflection.

For some reason, most engineering graduates are unaware of the variety of businesses in which they might be employed. They have no difficulty in realizing that large corporations and the government employ many engineers, but they seldom think that any other jobs are available. It is, therefore, not amiss to mention briefly some of these other opportunities.

MANY FIELDS OPEN TO ENGINEERING GRADUATES

The railroads of the country are just waking up to the fact that many trained engineers will be needed to operate and maintain their equipment in the future as this equipment constantly becomes more technically complex. The likelihood of the use of gas-turbine locomotives in the near future increases the chance that a young engineer may be hired by a railroad.

The paper mills of the country need mechanical engineers for maintenance and for production. A job with a paper company usually will prove to be very diversified and, for that reason, very interesting.

Other fields which can use engineers are department stores in maintenance, testing goods, or in buying; marine designers and operators; municipal engineering, including transportation; maintenance of truck and bus fleets; plumbing and heating; sheet-metal shops; small contractors; handling bank properties; buying for hardware stores, and assisting real estate agents.

At graduation time, young engineers quite often seek job advice from their professors or from engineers in industry. If this article in any way assists these older engineers in giving advice, it will have served its purpose.

PROPERTIES *of* METALS *at* ELEVATED TEMPERATURES

By G. V. SMITH

UNITED STATES STEEL CORPORATION, RESEARCH LABORATORY, KEARNY, N. J.

THE properties of metals at elevated temperatures are of interest for two principal reasons: (*a*) Metals frequently are formed or shaped while heated; in such processing, the metal is at elevated temperature for a relatively short time. (*b*) Metals are used in extended service at elevated temperatures as in power generation, oil refining, or chemical processing.

Among the properties of interest in the service of metals at elevated temperatures may be mentioned the following broad categories:

1 Strength.
2 Other physical properties such as thermal expansivity or conductivity, elastic moduli, and the like.
3 Resistance to scaling or other corrosive attack.
4 Changes in microstructure occurring during service, and the effect of these on the properties.

WORKING STRESSES

Although many properties are of interest in the use of metals at elevated temperatures, and individual ones will assume prime importance in specific applications, one overshadows all the rest. This is the matter of the strength and of the working stresses to be applied.

In the use of metals at or near room temperature, the working stresses employed for structures subjected to essentially static loading, as contrasted with dynamic or fatigue loading, are usually selected on the basis of the properties shown in the familiar tension test, Fig. 1. The working stress is generally selected to be less than the elastic limit, and, when the metal is subjected to this stress during service, it undergoes the corresponding elastic strain; on unloading this strain disappears.

Effect of Temperature. With increasing temperature, the load-elongation diagram is displaced to a lower level. This feature, as well as several others, may be noted in Fig. 2. This illustration shows the effects not only of temperature, but also of strain rate, on the load-elongation curve of 0.5 per cent molybdenum steel, such as has been widely employed in the past for steam-pipe service. The steel was tested not only in the condition in which it generally entered service, but also in a prespheroidized condition, which simulates the microstructural changes that occur during service. It may be noted that this treatment causes a decrease in strength. In regard to the effect of temperature, the tensile strength of the pearlitic material, for a strain rate of 7.5 in. per in. per hr, decreases continuously from about 56,000 psi at 850 F to about 38,000 psi at 1100 F.

The effect of strain rate becomes increasingly important with increase of temperature, as may be noted; at 1100 F, for the pearlitic material, the tensile strength decreases from about 38,000 psi to about 15,000 psi with change of the strain rate from 7.5 to 0.001 in. per in. per hr.

With decrease of strain rate at any temperature there is frequently observed to be a change in the character of the fracture, as evident in Fig. 3. At fast rates (short times for fracture), fracture of a ductile metal is accompanied by "necking-in," but at slow rates (long times for fracture), fracture is abrupt. When longitudinal sections through the fractures are prepared and examined, Fig. 4, it is found that the individual crystals or grains of which the metal is composed are distorted severely in the direction of stressing, and that the path of fracture is across the grains, i.e., transgranular, for fast rates of stressing, whereas grains remain as in the initial annealed

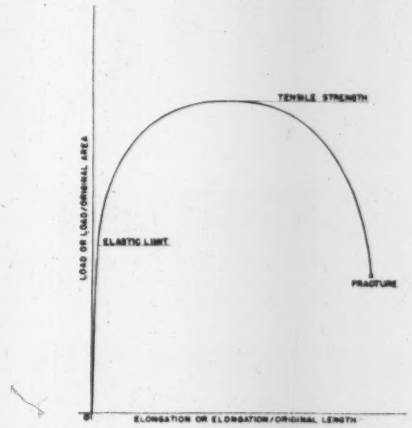

FIG. 1 SCHEMATIC TENSILE LOAD - ELONGATION CURVE

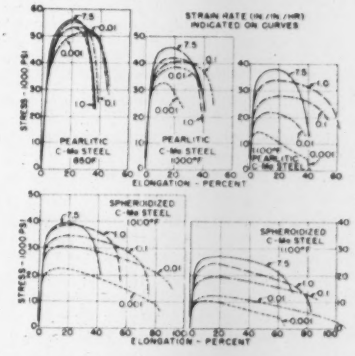
STRAIN RATE (IN./IN./HR) INDICATED ON CURVES
PEARLITIC C-½o STEEL 850°F
PEARLITIC C-½o STEEL 1000°F
PEARLITIC C-½o STEEL 1100°F
SPHEROIDIZED C-½o STEEL 1000°F
SPHEROIDIZED C-½o STEEL 1100°F
STRESS - 1000 PSI
ELONGATION - PERCENT

FIG. 2 STRESS-STRAIN CURVES FOR CONTROLLED STRAIN-RATE TENSILE TESTS OF PEARLITIC AND SPHEROIDIZED CARBON-MOLYBDENUM STEEL AT 850, 1000, AND 1100 F

Contributed by the Process Industries and Metals Divisions and presented at a meeting of the Metropolitan Section, New York, N. Y., March 7, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

metal, essentially equiaxed, in the slow-strain-rate fractures. Furthermore, the path of fracture is between the grains, i.e., intergranular. As the time for fracture increases, and the type of fracture changes from transgranular to intergranular, the total extension preceding fracture generally, but not always, diminishes to small values. Thus fracture frequently gives no warning that it is impending. While the change from transgranular fracture to intergranular has been stated to occur with increasing time for fracture, it also will occur with increasing temperature at constant strain rate.

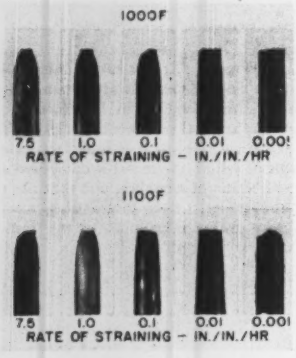

FIG. 3 SPECIMENS OF PEARLITIC C-MO STEEL AFTER FRACTURE AT VARIOUS STRAIN RATES AT 1000 F AND 1100 F; ×1

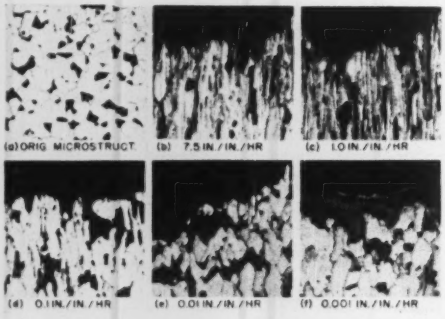

FIG. 4 LONGITUDINAL SECTION THROUGH FRACTURE OF CONTROLLED STRAIN-RATE TENSILE SPECIMENS OF PEARLITIC C-MO STEEL AT 1100 F; ×250

Creep. Since with increasing temperature or decreasing rate of straining the whole load-elongation curve is depressed, it is obvious that the permissible stresses to be employed for long-time service at elevated temperature must be less than at room temperature. Early designers assumed that all that need be done was to make a tension test at the temperature of interest, and then to use the same criterion of working stress as at room temperature. However, to their surprise, they observed that their structure did not undergo simply the immediate strain associated with loading, but instead, continued to deform with time. Thus they encountered creep, i.e., continuing deformation under essentially constant stress.

It was then considered that more sensitive extensometers should be employed so as to determine a limit below which creep would not occur. Unfortunately, this limit diminished the more refined the measurement, and was generally observed either to be nonexistent or so low as to make design quite uneconomical. When this was recognized, the modern viewpoint of design for creep service came into existence, namely, that the occurrence of creep should be recognized and design stresses be so chosen as to limit it to tolerable values.

Characteristics of Creep. With this brief background, let us consider the characteristics of creep phenomena in some detail. The characteristic form of the creep curve at constant load and temperature is shown in Fig. 5. On application of the load there is an immediate elastic extension along with some plastic extension. The further course of deformation then characteristically is such that the rate first decelerates, then remains substantially constant and minimum, and finally accelerates to fracture, or as it is frequently called, rupture. These several periods are often labeled primary, secondary, and tertiary creep, as indicated. While the figure illustrates the idealized course of creep, the actual curves may appear quite different. The load may be so low that for practical purposes creep ceases, whereas if the temperature is relatively high, the primary stage of creep may be virtually absent. Moreover, changes in microstructure may occur and significantly affect the course of the creep curve. In extreme cases, negative creep, that is, contraction under tensile load, may occur. But it is to be emphasized that in all cases the end result of creep is fracture.

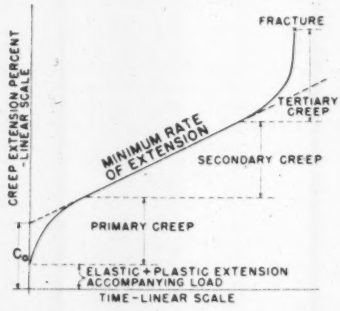

FIG. 5 CREEP CURVE AT CONSTANT TEMPERATURE AND LOAD

Fig. 5 also illustrates the two most important considerations in the choice of working stresses:

(*a*) By the very occurrence of creep, the engineer is faced with the fact that his vessel or part will change in dimensions with time, and therefore he must choose the working stress so that this deformation will not exceed during the expected life some permissible amount depending upon the application. Thus turbine blades may be designed for a life of 20 years in which time a total change in dimensions of 1 per cent may be tolerable. In contrast, a deformation of 5 per cent may not be excessive in a steam pipe, designed for the same period.

(*b*) The other principal consideration in the choice of working stresses is that, since the end result of creep is fracture, the design stress must be chosen so that fracture does not occur within the contemplated service life. Limitation of the total creep to 5 per cent or even 1 per cent does not necessarily insure that fracture does not occur, since the time for fracture does not bear any unique relation to the amount of deformation at fracture.

It is important to emphasize that there must, in theory, be a limited expected life—that when creep occurs, an indefinite life

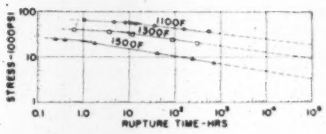

FIG. 6 STRESS VERSUS RUPTURE TIME; 18-8-MO

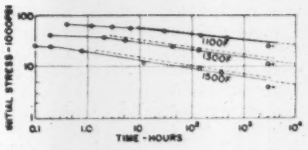

FIG. 7 STRESS VERSUS TIME FOR BEGINNING OF TERTIARY CREEP—SOLID LINES; STRESS VERSUS RUPTURE TIME—DASHED LINES, 18-8-MO

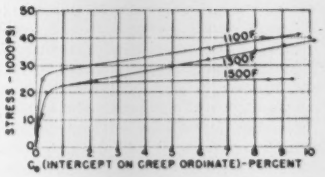

FIG. 8 INTERCEPT C_o VERSUS STRESS, 18-8-MO

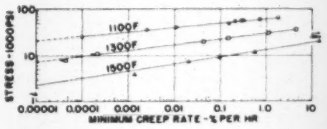

FIG. 9 STRESS VERSUS MINIMUM CREEP RATE; 18-8-MO

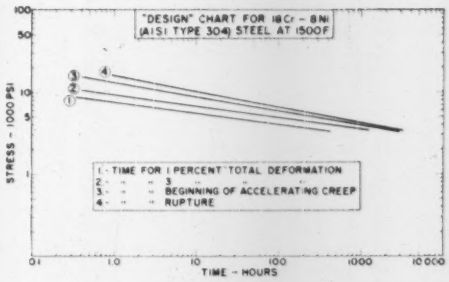
"DESIGN" CHART FOR 18 Cr - 8 Ni (AISI TYPE 304) STEEL AT 1500 F
STRESS - 1000 PSI
1 - TIME FOR 1 PERCENT TOTAL DEFORMATION
2 - " " 3 " " "
3 - " " BEGINNING OF ACCELERATING CREEP
4 - " " RUPTURE
TIME - HOURS

FIG. 10 "DESIGN" CHART FOR 18 CR - 8 NI STEEL AT 1500 F

cannot be anticipated since with time, either or both of two things may happen: (*a*) The strain which can be tolerated will be exceeded, and (*b*) fracture may result.

Thus, to repeat, the two principal considerations are that one should choose the working stress such that (*a*) some specific amount of creep is not exceeded; and (*b*) actual fracture does not occur. Intimately tied in with these limitations is the problem of the need for extrapolation in most applications, however distasteful, inasmuch as it is physically as well as economically impossible to conduct laboratory or acceptance tests for applications involving 20 years of service. How, then, shall we choose the working stress within these restrictions? The limitation of fracture is much the more easily effected. One simply makes creep tests at different stresses, determines the corresponding fracture times, and relates these graphically. The relation obtained is relatively simple, as we shall see later.

The relation between deformation and time is somewhat more difficult to evaluate, owing to the complex shape of the creep curve. What is probably the best means will be described. As evident in Fig. 5, the total deformation at any time earlier than the beginning of tertiary creep is given by the summation of the quantity C_o, which is the intercept of the minimum rate slope on the ordinate axis, and the product of the minimum creep rate and the time, or

$$C_t = C_o + \dot{C}_m t$$

where C_t is the total creep at time t, C_o is the intercept, $\dot{C}_m$ is the minimum creep rate, and t any time less than the beginning of tertiary creep. Thus, to calculate the total deformation for various stresses, one requires the relations between stress and the quantities: intercept C_o, minimum creep rate, and time for beginning of tertiary creep. These relations are obtained by testing a number of specimens each at different stress.

Let us examine the nature of these relations in terms of actual experimental data obtained on 18 Cr - 8 Ni-Mo stainless steel (AISI Type 316).

Stress Versus Rupture Time. Fig. 6 shows the relation between stress and time for rupture plotted to log-log co-ordinates, which for most but not all metals results in one or two straight lines. The change in slope is quite generally encountered if the range of temperature and deformation rate (time for rupture) are great enough, and seems to be associated with the change in type of fracture described earlier. Once the second slope has been established, there is little reason, on the basis of available experimental data, to expect a further change. Thus extrapolation to times beyond those which can be studied experimentally in the laboratory may be made with some confidence.

Stress Versus Time for Beginning of Tertiary Creep. The relation between stress and time for beginning of tertiary creep is generally observed, Fig. 7, to lie parallel to and below that for time to rupture. It will be recalled that the time for beginning of tertiary creep limits the calculation of total creep according to the means described previously.

Stress Versus Intercept C_o. The intercept C_o varies with the stress as shown in Fig. 8. For the data shown, the relation is composed of two linear portions of quite different slope which merge with one another. Whether such is generally the case is not known since relatively few data of this nature are yet available.

Stress Versus Minimum Creep Rate. The relation between stress and minimum creep rate is also linear on log-log co-ordinates for most materials, and thus suited to at least limited extrapolation, Fig. 9.

Design Charts. The data shown in the last several figures permit, within their limitations, the selection of working stresses such that (1) no more than a specific permissible strain will occur, and (2) fracture will not occur. It is of course first necessary to define the permissible maximum strain and the contemplated service life.

These data can be summarized in a useful and increasingly popular manner by the preparation of so-called "design charts," Fig. 10. In such a chart, stress is plotted against the times to attain various total deformations, such as 1 per cent and 3 per cent, and against the times for beginning of tertiary creep and for rupture. The data in the illustration are for 18 Cr - 8 Ni stainless steel (AISI Type 304).

Ductility at Rupture. We have not yet considered in this discussion the total deformation at rupture in creep-to-rupture tests. This is a matter of considerable interest even though, just as at room temperature, we cannot employ ductility directly in design formulas. Fig. 11 shows the variation of elongation and reduction of area at rupture of 18 Cr - 8 Ni-Mo stainless steel.

As with most other metals, this variation is rather erratic, although showing a general tendency for less ductility with increasing time to failure. As much as one might wish to know how much ductility could be anticipated at fracture in, say, 20 years, he would not wish to extrapolate the data.

Recently we have discovered a means which does appear to be suitable for making such predictions and which we have found to apply in all instances that we have examined. If one takes the ratio of the elongation or reduction of area, shown in Fig. 11, to the time for rupture, obtaining thus an average rate of deformation, he finds that this ratio plots linearly against

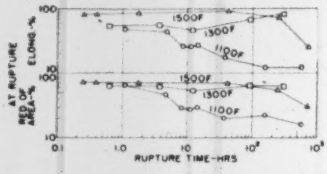

FIG. 11 ELONGATION AND REDUCTION OF AREA VERSUS RUPTURE TIME, 18-8-MO

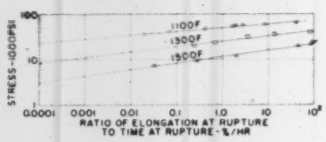

FIG. 12 STRESS VERSUS RATIO OF ELONGATION AT RUPTURE TO TIME AT RUPTURE, 18-8-MO

stress on log-log co-ordinates, Fig. 12. The linear relation is suited to extrapolation and permits the estimation of deformation at rupture. One simply determines, from the plot of stress versus rupture time, the stress to cause rupture in the time interval of interest; then determines the corresponding average rate of extension, which when multiplied by the time to rupture gives the extension at fracture.

Effects of Nonconstant Stress and Temperature, of Multiaxial and Fatigue Stressing. In the foregoing discussion we have considered the various characteristics of creep phenomena which are of interest in design for service at elevated temperature. The discussion has been in terms of the laboratory creep test carried out under ideal conditions of constant temperature and load, and generally under uniaxial tension. In service, temperature and load are often not constant, and stressing is multiaxial. Moreover, dynamic or fatigue stressing is often encountered. The application of laboratory test data to design, though difficult enough at ordinary temperature, is especially so at elevated temperatures.

Briefly, creep, under multiaxial stresses, has been studied by a number of investigators whose results indicate that the shear-strain-energy theory, which has been found to describe successfully the plastic flow of isotropic metals at ordinary temperature, may be similarly applied to creep flow.

The effect of nonconstancy of temperature and stress has not been studied in any great detail but in recent years interest has developed in this aspect of the problem, and experimental data are now becoming available. The effect of cycling may be expected to depend upon the material and the specific variation. The few data that are available on the effect of cycling temperature suggest that it may be rather pronounced at relatively high temperatures (perhaps above 1500 F for austenitic steels). More data are required.

It has often been suggested that the endurance or fatigue limit of metals at elevated temperatures is less than the creep strength. Further, that if the design stress does not exceed the creep strength, there is no possibility of fatigue failure. This of course is an oversimplification and is being increasingly recognized as such. Moreover, failures which are unquestionably of fatigue nature have been observed in elevated-temperature service. The oversimplification of the problem is no doubt attributable to ignoring at least two important considerations: (1) The endurance limit can be lowered radically by stress concentrations such as notches, abrupt changes in cross section, and the like; (2) the dynamic stress may be, and frequently is, not completely reversed but is superimposed upon a steady stress. In this latter case the problem of design is especially complex, for the steady stress may be sufficient to cause creep at the same time that the dynamic stress is causing fatigue damage, giving rise to what might perhaps be called a creep-fatigue failure, showing characteristics of both phenomena. Regrettably, few fatigue tests have been made at elevated temperature under other than completely reversed cycles of stress. Fortunately, interest has developed (in recent years) in this long-neglected aspect of the use of metals at elevated temperatures.

Effects of Metallurgical Variables. The creep characteristics of metals are profoundly influenced by various metallurgical variables, chief among which are chemical composition and manufacturing practices (deoxidation practice and heat-treatment). The most important of these variables is of course chemical composition. Fig. 13 has been prepared to indicate the possible range. This figure shows graphically the temperature variation of the 1000-hr rupture strength of several common steels in comparison with one of the strongest of the so-called "superalloys" developed for gas turbines, jet aircraft,

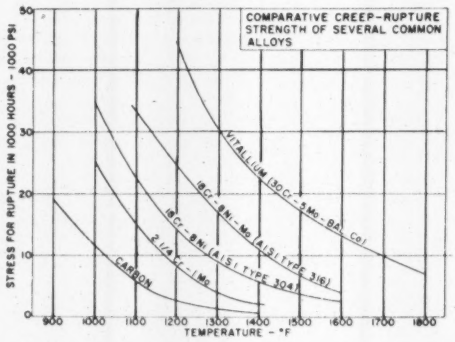
COMPARATIVE CREEP-RUPTURE STRENGTH OF SEVERAL COMMON ALLOYS
STRESS FOR RUPTURE IN 1000 HOURS - 1000 PSI
TEMPERATURE - °F
VITALLIUM (30 Cr - 5 Mo - BAL. Co)
18 Cr - 8 Ni - Mo (AISI TYPE 316)
18 Cr - 8 Ni (AISI TYPE 304)
2 1/4 Cr - 1 Mo
CARBON

FIG. 13 COMPARATIVE CREEP-RUPTURE STRENGTH OF SEVERAL COMMON ALLOYS

and similar applications. By variation in manufacturing practices such as melting, deoxidation, and heat-treating processes, the strength of any one alloy can be altered radically. The superalloys, which have been developed largely during the last decade, have become of considerable importance. At 1200 F they are about 3 times as strong and at 1500 F about 6 times as strong as ordinary stainless steel. The advantage of the superalloys also can be expressed in terms of temperature; since a number of them have the same strength at 1500 F as do the stainless steels at 1100–1200 F, they permit an increase in the working temperature of 300–400 F.

MICROSTRUCTURAL AND SURFACE CHANGES

Two other broad aspects of the behavior of metals at elevated temperature should be mentioned, namely, the changes in microstructure which bring about changes in strength with time at temperature, and scaling or other corrosive attack of the metal in the environment to which it is subjected.

Microstructural Changes. A number of changes in microstructure may occur in metals merely as a consequence of time at temperature. These changes occur independently of, but may be altered by, stressing. They are a result of the striving of the metal to attain thermodynamic equilibrium. Among the changes which may occur are carbide spheroidization, graphitization (this change has been of considerable interest to power-generating engineers in recent years), allotropic transformations, strain-aging, and precipitation processes of one kind or another. The changes which occur in one specific alloy, 18 Cr-8 Ni-Mo (AISI Type 316), are shown in Fig. 14. In this alloy, carbide and sigma phase (not differentiated in the figure) precipitate in the initially homogeneous matrix. It should be

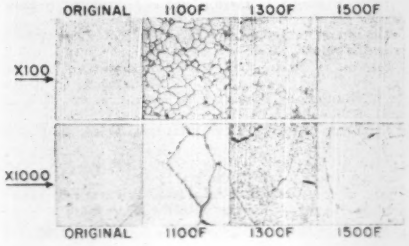

FIG. 14 MICROSTRUCTURAL CHANGES IN 18-8-MO DURING 3000-HR CREEP TEST

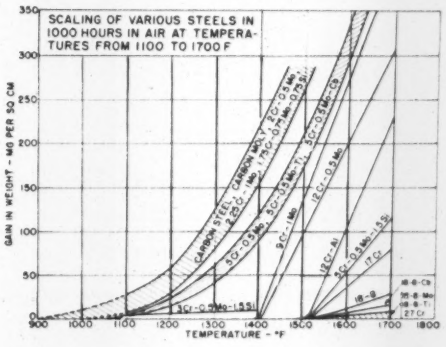
SCALING OF VARIOUS STEELS IN 1000 HOURS IN AIR AT TEMPERATURES FROM 1100 TO 1700 F
GAIN IN WEIGHT - MG PER SQ CM
TEMPERATURE - °F
CARBON STEEL, CARBON-MOLY
18-8
18-8-Cb
18-8 Ti
27 Cr

FIG. 15 SCALING OF VARIOUS STEELS IN 1000 HR IN AIR AT TEMPERATURES FROM 1100 TO 1700 F

apparent that important differences exist which may be expected to alter the properties.

The microstructural changes which occur in a metal during service at elevated temperature cause changes in properties, not only at the temperature of service but at other temperatures as well. Thus the alloy changes continuously during service; it may become weaker or stronger, tougher or more brittle, depending upon the specific changes which occur.

Scaling or Other Corrosive Attack. The effect of scaling or other corrosive attack is to reduce the effective cross-sectional area of the metal, or, when the attack is localized, to cause stress concentrations. Fig. 15 shows the comparative scaling resistance of various commercially used steels.

The most important alloying element for improvement of the scaling resistance of steel for service at elevated temperatures is chromium. The addition of this element results in

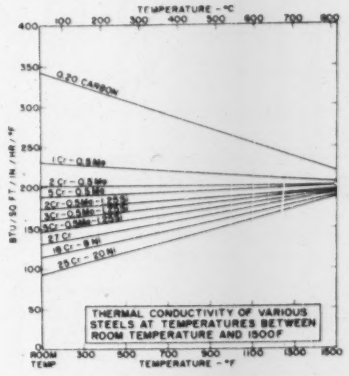
TEMPERATURE - °C
0.20 CARBON
1Cr - 0.5 Mo
2Cr - 0.5 Mo
5Cr - 0.5 Mo
9Cr - 1 Mo
18 Cr - 8 Ni
25 Cr - 20 Ni
BTU/SQ FT/IN/HR/°F
THERMAL CONDUCTIVITY OF VARIOUS STEELS AT TEMPERATURES BETWEEN ROOM TEMPERATURE AND 1500 F
ROOM TEMP
TEMPERATURE - °F

FIG. 16 THERMAL CONDUCTIVITY OF VARIOUS STEELS AT TEMPERATURES BETWEEN ROOM TEMPERATURE AND 1500 F

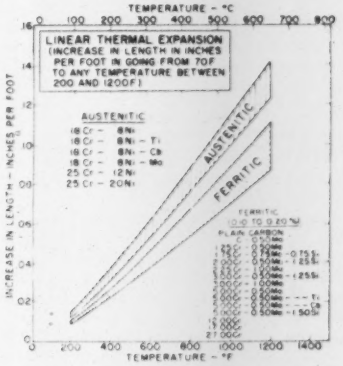
TEMPERATURE - °C
LINEAR THERMAL EXPANSION (INCREASE IN LENGTH IN INCHES PER FOOT IN GOING FROM 70 F TO ANY TEMPERATURE BETWEEN 200 AND 1200 F)
AUSTENITIC
FERRITIC
INCREASE IN LENGTH - INCHES PER FOOT
TEMPERATURE - °F

FIG. 17 LINEAR THERMAL EXPANSION

the formation of a so-called protective oxide, which retards further scaling. Other alloying elements such as silicon and aluminum act similarly, but can be used only in limited amount owing to adverse effects on mechanical properties.

MISCELLANEOUS PHYSICAL PROPERTIES

Various other properties are of interest in design for elevated-temperature service, although these are not generally controlling factors. Among such properties are thermal conductivity and expansivity and the elastic moduli.

Fig. 16 shows the temperature variation of thermal conductivity of a number of ferrous alloys. It is to be noted that the wide differences in thermal conductivity tend to diminish with increasing temperature.

Fig. 17 shows the length changes which result when various ferrous alloys are heated. It will be noted that the austenitic (18 Cr - 8 Ni type) steels undergo appreciably greater length changes than the ferritic steels.

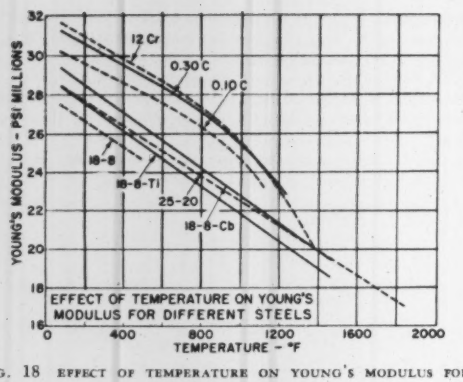

FIG. 18 EFFECT OF TEMPERATURE ON YOUNG'S MODULUS FOR DIFFERENT STEELS

Finally, Fig. 18 shows the temperature variation of tensile elastic modulus of several alloys. A general downward trend of modulus is to be noted as the temperature is increased.

SUMMARY

In this brief consideration of the properties of metals at elevated temperature an attempt has been made to furnish a broad over-all view of the problem. Much of the discussion has been devoted to a consideration of creep phenomena, for, while other properties are of interest, they are generally subordinate.[1] Because deformation continues to occur with time in service at elevated temperature, with the end result of fracture, logic demands that economical design be predicated on a limited life rather than an unlimited one. Within this planned life interval, the stress must be so chosen that a maximum permissible deformation is not exceeded and then that fracture does not occur.

It has been pointed out that the translation of laboratory data to actual service is an especially complex problem which, however, is being solved as more data regarding service behavior become available.

[1] Important exceptions exist. Thus at very high temperatures such as contemplated for certain superalloy applications, scaling resistance may be the limiting factor.

REFERENCES

1 "Influence of Strain Rate on Strength and Type of Fracture of C-Mo Steel at 850, 1000 and 1100 F," by R. F. Miller, G. V. Smith, and G. L. Kehl, Trans. ASM, vol. 31, 1943, p. 817.

2 "Creep Tests," by J. J. Kanter, Metals Handbook, ASM, 1948, p. 115.

3 "Creep of Metals," by H. J. Tapsell, Oxford University Press, New York, N. Y., and London, England, 1931.

4 "Mechanical Properties of Materials and Design," by J. Marin, McGraw-Hill Book Company, Inc., New York, N. Y., 1942.

5 "Metallic Creep," by A. H. Sully, Butterworth's Scientific Publications, London, England, 1949.

6 "Creep and Rupture of Several Chromium-Nickel Austenitic Steels," by G. V. Smith, E. J. Dulis, and E. G. Houston, Trans. ASM, vol. 42, 1950, pp. 935-980.

7 "The Interpretation of Creep Tests," by P. G. McVetty, Proceedings of the ASTM, vol. 34, 1934, p. 105.

8 "Fracture of Steels at Elevated Temperatures After Prolonged Loading," by E. R. Parker and R. H. Thielemann, Trans. American Institute of Mining and Metallurgical Engineers, vol. 135, 1939, p. 559.

9 "The Creep of Metals," by D. Hanson, Trans. AIME, 1939, pp. 15-57.

10 "Some Things We Don't Know About the Creep of Metals," by H. W. Gillett, Trans. AIME, 1939, pp. 15-58.

11 "The Plastic, Creep and Relaxation Properties of Metals," by A. E. Johnson, *Aircraft Engineering*, vol. 21, 1949, p. 2.

12 "The Use of Creep Data in Design," by H. C. Cross and L. R. Jackson, ASTM San Francisco Meeting, October, 1949.

13 "Steels for Elevated Temperature Service," United States Steel Corporation, 1949.

14 "Properties of Metals at Elevated Temperatures," by G. V. Smith, McGraw-Hill Book Company, Inc., New York, N. Y., 1950.

Liquid Metals Handbook

A NEW 194-page "Liquid Metals Handbook" has been published under the joint sponsorship of the Atomic Energy Commission, the Office of Naval Research, and the Navy Bureau of Ships.

Since liquid metals may be used as coolants in nuclear chain reactors producing power, the fundamental information given in the "Liquid Metals Handbook" is of particular interest to reactor designers. However, publication of the book is expected to encourage use of liquid metals in other industrial applications, and thereby increase the number of technical personnel trained to work in this relatively new field of technology.

Much of the information compiled in the book was obtained during the last few years from research sponsored by the AEC and the two Navy Department agencies, although private industrial laboratories have also contributed.

Information is compiled on metals having low melting points so that they become liquid at room temperature or within a few hundred degrees of room temperature.

Since their boiling points are considerably higher than that of water, liquid metals can be used at higher temperatures without a pressurized system. For this reason liquid metals have an advantage over water as heat-transfer agents.

The metals discussed in the "Handbook" include the following: aluminum, antimony, bismuth, cadmium, cesium, gallium, indium, lead, lithium, magnesium, mercury, potassium, rubidium, sodium, thallium, tin, zinc, and several alloys.

The subject matter covered by the "Liquid Metals Handbook" is shown by the following list of chapter titles, authors, and research agencies:

I Physical Properties of Some Liquid Metals, by R. R Miller, Naval Research Laboratory, Washington, D. C.

II Chemical Properties and Laboratory Techniques, by C. B. Jackson, Mine Safety Appliance Company, Pittsburgh, Pa.

III Resistance of Materials to Attack by Liquid Metals, by L. R. Kelman, Argonne National Laboratory, Chicago, Ill.

IV Availability, by I. R. Kramer, Office of Naval Research, with the assistance of the U. S. Bureau of Mines.

V Heat Transfer, by R. N. Lyon, Oak Ridge National Laboratory, Oak Ridge, Tenn.

VI Large-Scale Handling, by K. D. McMahan, Knolls Atomic Power Laboratory, Schenectady, N. Y.

VII Industrial Utilization, by D. L. Katz, Department of Metallurgy, and Chemical Engineering, University of Michigan, Ann Arbor, Mich.

The "Liquid Metals Handbook" may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at $1.25 per copy.

Postwar DEVELOPMENTS *in* FOREST-PRODUCTS RESEARCH

By C. A. RISHELL

DIRECTOR OF RESEARCH, TIMBER ENGINEERING COMPANY, WASHINGTON, D. C.

TECHNICAL PROGRESS

PROBABLY those who are responsible for technical progress in all industries are prone to underestimate the advances that have been made and, for the most part, see only the things that should be done. Therefore this paper unintentionally may present the gloomy side of the picture as it exists in the wood-products industry. However, there are many progressive firms which are using trained technical personnel and are engaging in research on a par with other industries both in quality and quantity.

A compilation of the researches made by the progressive lumber and wood-products manufacturers, if it could be undertaken accurately, would be of extreme interest and value. It would encourage the less progressive firms to do something for themselves and it would also encourage our engineering and forest-utilization schools to turn out men specifically trained for the jobs which must be undertaken.

Volumes have been written with respect to the type of research and quantity of research that is needed by the wood industry. However, most of these presentations fail to get at the core of the problem, and, even though they give us valuable information as to what should be done, they do not tell us how it can be done.

The chief reason for lack of progress in modernizing the wood industry is that trained men have not filtered into the industry in sufficient numbers to give it the required momentum.

The lumber industry, with the possible exception of agriculture, is one of the oldest existing in America. When the colonists first came to this country, all that they had to work with were the raw materials on the land. Hence wood, being more plentiful and more easily worked than most materials, became the chief source for the products that made life possible. From this beginning, where every man made with his own hands the things that he used, a small lumber industry took root. Water power furnished the energy to operate the crude whipsaws of those days. Sawed boards replaced logs and hand-hewn materials for buildings, furniture, and other necessities. The lumber industry became widespread, but always the units were small and designed mostly for taking care of the local needs of the particular community.

SMALL UNITS PREDOMINATE

One of the principal reasons for the small size of manufacturing lumber units was the cost and lack of adequate transportation. To a certain extent the same thing applies today. Transportation is adequate now, but the cost of transporting raw materials, such as rough lumber in its present form, is such that probably the bulk of our timber is still produced by small units located to serve the respective communities.

Small manufacturing units when prevalent in an industry are apt to restrain technical progress. This is not meant as a criticism of our present system. The small units have served their purpose in the past, are doing a magnificent job today, and will continue to serve as long as trees grow.

Since much of the lumber industry is and must be made up of widely scattered small units, we must consider the problem from that angle and recognize that the job of modernizing is more difficult than where industries are compact and composed of a few large concerns such as the steel industry, the chemical industry, and others. If the facts be examined, it will be found that in these compact industries technical progress has been very rapid. Compactness and wealth of an industry are of course only two of the influencing factors.

Other things can be mentioned such as extreme necessity. Wood for a great many purposes is so easily worked that a reasonable use has been possible without developing highly technical processes. This will always be true. The wood industry may lose many of its present markets but it will never lose them all, and it will always be a favored raw material. It has its faults as all other raw materials have but one of its big advantages is that it can be used by relatively unskilled people whereas materials such as metals, chemicals, and the like, to a great extent must be developed and fabricated by technically trained personnel. Research in these other industries has, therefore, been a necessity. They could not have obtained a foothold without technical progress. The strength of the lumber industry in the past is in some respects its present weakness.

In order to obtain technical progress, it is necessary that administrators and executives in the lumber and wood-products industry be technical people themselves. This does not mean that we cannot have technical progress without college-trained men. Many of our finest scientists and our best executives have never had the benefit of a formal training, but in some way or other they have trained themselves. A formal technical education is always helpful.

Therefore, the first necessity is that highly trained men to a very large extent take over the administration of the forest-products industries. Nothing that management or technical schools can do will change this. However, there are ways to hasten the procedure.

If our technical schools train men properly with full knowledge of the problems of the industry, these men can filter into the production plants in positions which at the moment are not of the executive type but positions which will provide the trainee with that necessary practical experience in production which he cannot learn in school.

Nontechnical executives usually do not understand the barest fundamentals of technical progress. For example, the author knows of plants where haphazard methods for determining moisture content of lumber are still used. A few years ago when training kiln operators for a large lumber concern, it was usual practice to determine the moisture content by boring a hole in the side of a board. If the sawdust which came out of the hole smelled wet and had the general appearance of having a high moisture content, it was decided that the lumber was

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not dry enough to use. Even today the personnel of many companies are not trained in the use of moisture meters and do not know how valuable these inexpensive and easily operated instruments can be.

A situation such as this seems inexcusable but management does not understand the problems of technical advancement.

FUNDAMENTAL VERSUS APPLIED RESEARCH

The forest-products industries are doing a considerable amount of applied research. Some statistics on the quantity of research will be presented later on. However, with only one or two exceptions, fundamental research is not known or practiced in the industry. Fundamental research is expensive. It is a long-time proposition. It is difficult to understand, and it may or may not develop products along lines familiar to the firm that is practicing it. However, if the industry in some way can finance fundamental research, it will have tremendous value in years to come.

The author has always desired that our own company laboratory have a relatively large sum of money which could be used by our personnel to make fundamental investigations without the necessity for showing an immediate profit from the investigations. Eventually, such an investment would pay off. Highly trained scientists must be allowed to develop along the lines of their own thinking. It is a waste of time and brains to employ such people and then hamper them in developing initiative.

However, fundamental research being what it is—expensive and difficult to understand—for the moment at least must be left to the public institutions and our universities.

It should be the general scheme of things to bring thoroughly trained technicians into the lumber industry in such a way that their training will immediately show a profit. There are many places where this can be done. For example, we need trained kiln operators. These men must take the place of the untrained. Technically trained personnel will not be satisfied with the present methods. They will develop new processes and they will improve the old ones.

In operations where glue is used, technical personnel can revolutionize the present systems. It is a long cry from the old-fashioned glues that could be handled easily for general-purpose jobs to the new types of specialized glues which require for their proper use an understanding of chemistry and the technology of wood. The fabricating industry is trying to do a job with unskilled personnel. So far it has been relatively successful but, as time goes on, if the present situation continues to exist, we will have to forego the use of many new modern glues.

The methods for finishing furniture are little different from what they were 25 years ago. Here again, chemical processes are involved and the industry is trying to conduct a chemical operation without chemists. Highly trained men for this purpose are needed.

In the manufacture of lumber and the machining of wood, advancement has been due almost entirely to the development of improved metals for machine tools. We have done nothing to help the metallurgist, much less to improve our methods of using the new metals. Lumber is planed today in the same way it was 30 years ago. We saw about the same way with the same general type of saws. We have added a few ball bearings to the machines, which reduces power consumption and permits higher speeds, but the industry can be on the threshold of a revolution in machining if it will employ technically trained personnel.

ELECTRONIC INVESTIGATIONS

The wood industry has to a very small extent used electronic devices but the credit for developing these devices and for the use of them is not that of the wood industry. It has probably resisted rather than assisted the electronic-equipment manufacturers in developing machines for our use.

In spite of ourselves, high-frequency gluing has become widespread, but there are many other jobs that electronics can do for us. For example, we need to investigate drying and treating methods thoroughly. We probably can use electronics to help us stabilize lumber against shrinking and swelling. We can use electronic equipment to detect metals in wood, to determine its density, and perhaps to help us to do better machine jobs.

We need new methods for quality control. Many products are now being made by the industry that, undoubtedly, could be tested by electronic devices to determine strength so that it would be definitely known whether each piece for a critical item has the necessary strength. For example, parts for wood ladders are all strength members and, if weakened by unknown defects, may cause injury or death to the user. Airplane parts, scaffolding, staging material, and many other products require a higher order of quality control than we have so far developed.

For work in electronics we need men of the highest technical ability.

ECONOMIC STUDIES

Most industries familiar with research, before undertaking the production of a new item, make an intelligent economic survey to determine the size of the potential markets. For example, some chemical concerns produce waste materials that can be used effectively for preservative treatment of lumber. The marketwise firms do not go out haphazardly to sell products in an undeveloped market, but they first undertake an economic survey to determine whether the development is sufficiently worth while to justify the necessary expense.

In contrast with this, the lumber industry when it sets out to develop or sell a new product usually takes a chance. Sometimes it hits the jackpot. Usually it does not. This type of haphazard market development has created resistance by management to venture into new fields. However, it can be expected that as time goes on and experience is gained, young men suitably trained for economic surveys will be employed to handle the situation. This type of work not only requires a technical education but a thorough understanding of the problems of the wood industry.

CHEMISTRY AND ENGINEERING DESIGN ARE NEEDED

Many wood-producing concerns have been able to progress because they have employed chemists. For example, there are firms in the wood industry which are working with sawdust and other waste materials to develop hardboards, insulating boards, synthetic molding, fertilizers or soil improvers, fuels, and so forth. These organizations are using chemically trained technicians.

The industry needs to design new products and redesign many of the older ones. For example, a great deal of lumber goes into the construction of boats. Wood boats, other than those made of plywood, are almost identical to those which were produced a hundred years ago. Newer materials are coming on the market. Boats are being built with them. It is claimed they will not leak when dried by the sun nor will they be attacked by shipworms. All materials have certain weaknesses. It may be presumed that these newer ones are not excepted. But that is no reason why the wood-boat industry should sit on its heels to wait for something to happen. It should start immediately to improve its own products.

Forty years ago all desks and other office equipment were of wood. Today only 50 per cent of the desks manufactured are

of wood, and less than 7 per cent of the filing cabinets. This is not because wood doesn't make good office furniture. In fact, wood is usually preferred by executives for their own use. It has certain properties that make it desirable and most comfortable to use, but, partly because we have not improved designs, we are losing the markets for the less expensive products.

Many of our chairs such as the folding variety and outdoor chairs are now being made of steel. We need new designs so that wood chairs will give better and cheaper service. These are only a few of the things where technical design is needed by the industry and where many highly trained men can be used.

MODERNIZING THE PRODUCTION LINE

Even in our sawmills and other production plants, we need intelligent thought and planning to redesign our production lines. Often they are so antiquated that the cost in raw material and labor is more than double what it should be. Some years ago the author worked with a manufacturer of hardwood flooring. By redesigning the production line the waste in raw material was reduced 50 per cent, the market value of the product was doubled, and production costs were reduced.

In co-operation with design engineers we need efficiency engineers who can work hand in glove with them. It is true that there are outside efficiency companies who will for a fee go onto a job and then make recommendations that may be helpful. But the industry needs its own efficiency engineers—men who are trained in this particular field, probably by the company itself.

Regardless of improvement in machining equipment or the skill of the manufacturer in reducing waste, the machining of lumber will always produce quantities of wood waste. Chemists, chemical engineers, mechanical engineers, plastic chemists, and others should be turned loose to utilize the raw material which is now being wastefully used for fuel or worse still is being burned without recovering the heat value of the wood.

OUR PRESENT WOOD PRODUCTS

From the foregoing one is apt to infer it to be the author's opinion that our present wood products are not designed soundly, sold properly, or that the physical structure of our industry is entirely wrong. Such is not the case. If it were so, our mills would not be producing large quantities of lumber. Our production today is on a reasonably satisfactory basis. Probably no other material can provide us with the economic housing which we have known in America, or the fine furniture which is universally used. The problem is not whether our products and materials are good, but whether we can make them better. One way of making them better is to use them in combination with other materials to reduce cost and provide improved quality.

For example, the composite type of automobile body which was superseded by the all-steel body only a few years ago was probably superior in strength to its successor and much superior to the early all-wood body. The loss of the market was due almost entirely to economic factors.

Today most of the large truck bodies and the special-service type are of composite construction. We can probably hold these markets, especially if we proceed along technical lines, such as using new laminating procedures.

The wood station-wagon body is rapidly giving way to steel because it was not economical to produce and was unsatisfactory in service. In this case a modest sum spent in technical developments to improve durability probably would have saved the market.

That we have lost many other markets because of lack of technical improvements in design and low-cost manufacture can be ascertained quickly by looking into the windows of sporting-goods shops, automobile salesrooms, furniture stores, and others. A few illustrations will serve to emphasize the point as follows: Automobile bodies, picture moldings, flooring, office furniture, candy sucker sticks, boats, containers, airplanes, instrument cases, blocks and pulleys, gun stocks, folding chairs, and home cabinets. In the foregoing list some of the items deserve further mention. Picture moldings, for example, have to a very large extent gone to synthetic or molded-type products. It is not hard to understand why this is so. Perhaps it is not a large market but it is worth-while maintaining. We have lost many markets formerly held by wood flooring. Asphalt tile can be produced very cheaply and has been able to compete in many types of buildings.

The lowly stick for the all-day sucker is only a small use for wood but illustrates a point. It seems impossible but true that sucker sticks can be made of wound paper cheaper than from the wood dowels. Fiber containers, because of skillful technical progress and millions of dollars worth of research, have made huge inroads into the market which was formerly controlled almost 100 per cent by wood.

The finest television and radio instruments are advertised as having wood cabinets. However, for the highly profitable low-cost market, plastic cases have taken over the field. The production of wood cabinets is too expensive.

Many of the cheaper sporting rifles are now equipped with plastic stocks. In appearance they resemble wood, but the principal virtue is low cost.

We cannot save every market through technical research and the employment of technical personnel, but we can hold many of them and for those which we lose we can gain replacements.

The wood-products industries are vitally concerned with our transportation system. As stated, one reason for localizing lumber production was the lack of adequate transportation. Even with the most modern rail, water, and truck systems ever developed, we have not solved our problems in the economics of transportation. Lumber is a raw material and, except for the best grades, is not highly refined. For every clear piece of lumber that is produced, there are several boards that have defects or waste that cannot be used in finished products. Highly trained, skilled technicians are needed to overcome this problem which when accomplished will reduce the cost of wood products to the consumer.

In the field of wood research many men could be employed beneficially to develop systems for stabilizing wood against shrinking and swelling. There is probably no technical problem facing the industry of more importance than this, yet our research organizations have displayed little interest in the problem. If we learn to stabilize wood economically, we can provide much better finishes. We can build stronger structures. By stabilizing it we can make it more comfortable to use by preventing the shrinking and swelling of drawers and the sticking of doors.

PAINTS AND FINISHES

We have fairly reliable house paints that can be depended upon for years of service. Perhaps they can be improved and should be, but, for many other products, our present finishes are woefully lacking. For example, finishes have been developed for the metal surfaces of automobiles that will endure years of outdoor service; but we cannot use these finishes on wood, nor can we expect the durability of any known wood finish to equal that on the automobile or the porcelain refrigerator. This need not be so. Perhaps overlays of plastic such as fiberglass or other materials can be used to overcome these difficulties.

However, we have made some improvements in finishes. For example, it is now possible to purchase furniture that has

cigaretteproof tops. We have perfected hardened furniture legs so that the wood desk, for example, is much better than it was several years ago. But the improvements which we have today have been possible only because the industry has technicians who are working in a virgin field.

Many markets have been lost to the lumber industry because we have not developed new product designs that lend themselves to mass production. We have difficulty in competing with steel stampings or plastic moldings; they may not look as good as wood or be as desirable, but they are cheaper and serve the purpose. A complete list of the loss of markets because of antiquated design would be very long.

WHAT ARE WE DOING IN WOOD RESEARCH?

In general the picture is not too black. Probably we will never be satisfied and certainly now is no time to rest on our oars. While we have accomplished a great deal, the harder jobs still face us, and more technical personnel must be employed to tackle these problems.

At the present time many technical men are employed by the industry. The extent of this employment is more widespread than is generally known. The paper industry is dependent for its progress on its extensive technically trained personnel. Much of our plastic industry is based on modern technical development.

There are many highly improved glues on the market. These could have been developed only by the painstaking work of scientists. The impregnation of wood with decay-preventive materials is widespread. This development by engineers and wood-utilization technicians is of tremendous importance and is not fully valued. Practically our entire railroad system rests on treated wood. Not many years ago the average life of a railroad crosstie was 5 years. Today 20 to 25 years is not unusual.

We have stress grades of lumber and timber connectors which make it possible to build huge structures of known and dependable strength. These technical developments are entirely the result of research work and have made it possible for wood to more than compete with other materials.

Hundreds of men have been engaged in these activities. There is no reason for the engineering, chemical, or forestry professions to feel despair.

In accordance with the best information, 12,500 wood research projects have been completed or are being undertaken, currently. Of these projects 45.2 per cent have been in the chemical and chemical-products field; 15.6 per cent in processes, materials, and devices used with wood in order to improve or modify its properties and use; 11.3 per cent in the field of primary timber and lumber products; 8.7 per cent of the projects have been devoted to structure, identification, and properties of wood; 10.7 per cent to fabricated wood products; 6 per cent to building, building parts, and other structures, and 2½ per cent to means and devices for the selection of wood.

Many of the twelve thousand odd projects are small. The figures serve only to show that wood research is widespread.

In order to assist technicians in obtaining work in the industry or the research organizations which are working for it, it is desirable to have some knowledge as to where these researches are being conducted.

There are 118 colleges and universities in the United States conducting wood research, 97 Federal and state organizations, 238 manufacturers of forest products, 868 processors, consumers and materials suppliers, 201 professional societies and commercial laboratories, and 98 trade associations, all of whom are undertaking wood research in some form or other. Some of the projects are large, some are small, and the foregoing figures of course give no indication as to the dollar value of the research in the various subdivisions mentioned.

SOME NEEDED RESEARCH

This Society is interested in the type of research projects which should be undertaken immediately. It should be understood that those which are listed may not be the most important nor are they necessarily in the order of importance:

1 Surveys to determine quantity, location, and form of waste wood. Also surveys to determine the economics of various researches now under way. For example, what are the potential U. S. markets for hardboard, feeding yeast, molasses, fertilizers, etc.? What influence have freight rates on the use of wood for such purposes?

2 A more comprehensive compilation of all known research in wood. The Forest Products Research Guide, published by the Committee on Products and Research of the National Lumber Manufacturers Association, is a beginning but only scratches the surface. It tells where research is being done but not how much or the value of it. Also there is no complete bibliography on research.

3 Research co-ordination is badly needed, not only to prevent duplication but to prevent the loss of valuable research data. During the war the Government and private industry conducted hundreds of unco-ordinated projects. The value of much of this work will be lost because there is no complete centralized recording of these data. For example, a review committee working under the direction of the Munitions Board surveyed all government specifications for articles where wood is used. These data which required thousands of hours to prepare now seem to have been lost.

4 Research to develop processes for stabilizing wood to resist shrinking and swelling. Both fundamental and applied research are necessary.

5 Research in lignin.

6 Elimination of defective material from low-grade lumber at the source of production rather than in the fabricator's plant.

7 Improvements in drying and pressing equipment for hardboards from wood waste.

8 Improved design for woodworking equipment.

9 New fast adhesives, particularly of the waterproof variety, and simple inexpensive equipment for obtaining required clamping pressures, especially for curved members.

10 Inexpensive (portable and permanent) equipment for debarking small logs, slabs, and other sawmill and woods waste.

INDUSTRY ORGANIZATION RESEARCH

The National Lumber Manufacturers Association has long been engaged in certain phases of research. Until 1941, this type of work was confined to market surveys, statistical studies, etc. It did not engage in the so-called laboratory type of research. However, it was realized by the directors that in order to do a reasonable over-all job in the field, a laboratory would be necessary.

The Timber Engineering Company, which is affiliated with the National Lumber Manufacturers Association, is the organization that undertook the development and marketing of timber connectors. The work accomplished by this company is probably outstanding in technical development in the lumber industry, but the company has since gone much further by constructing and operating a technical laboratory located on the outskirts of Washington. The number of employees at the laboratory is not great, but in the past 6 years it has de-

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The ENGINEERING TEACHER

By A. A. POTTER

DEAN OF ENGINEERING, PURDUE UNIVERSITY, LAFAYETTE, IND. PAST-PRESIDENT, ASME

THE Society has always been ready to recognize and to honor engineering teachers by selecting them for important committee assignments and by electing them to high offices. Since its foundation in 1880, the Society has had 68 presidents, and of these 13 were engineering teachers—a very large number considering the small percentage of teachers in the membership.

The members of our profession recognize that the central figure in any educational process is the teacher. Excellent physical plants, winning athletic teams, good public and alumni relations, and effective administrative officers are very important factors in higher education, but these are useless without good teachers. A college or a university is largely the reflex of its teachers.

OBJECTIVES OF ENGINEERING EDUCATION

Before discussing the factors which contribute to effective teaching, it may be well to define the objectives of engineering education and to appraise the essentials of good teaching.

The purpose of education is to civilize and humanize our young people so that they will fit into their environment and will make contributions as useful citizens. These are also the objectives of engineering education. We are interested in having the engineer become not only useful and competent in his field, but also a good citizen with a broad perspective, an open mind, and with a critical and constructive approach to life; an individual who thinks clearly, acts courageously, and feels nobly toward others. Good engineering education should strive to develop the ability to do and to create as well as to think, to communicate; it should train to make valid judgments and to evaluate ethical as well as practical situations. H. P. Hammond of the Pennsylvania State College recently summarized the essentials of good teaching in one sentence as follows:[1]

"Good teaching is the development of the student's ability to do things for himself."

Engineering teaching is concerned with the acquisition of knowledge and should aim to develop in the student also an appreciation of the engineering or scientific method. Above all, it must strive to inculcate in the learner a realization that the best education is self-education, and that a good engineer is able to do things on his own initiative.

Engineering colleges have in the past looked upon undergraduate instruction as their main function and good teaching as a major responsibility. The value of engineering education on the graduate level is evidenced by the rapid growth of engineering-graduate enrollments during the past decade. Industry is beginning to pay a good premium to those with advanced degrees. Research is also being recognized as a most valuable tool in our educational kit, as it develops on the part of the teacher-investigator a craving for creativeness and affords him an experience which should enable him to recognize in his students and colleagues potential productivity. Care, however, must be taken that pressure for larger graduate-student enrollments and for more research does not result in conditions so often found in many of our university departments where the teaching of undergraduates is left largely to inexperienced candidates for advanced degrees, or to unimaginative and unproductive older staff members.

RESEARCH TRAINING NOT THE PRIMARY OBJECT

Dr. Frederic Lilge of the University of California, in his book, "The Abuse of Learning," states that decay, which undermined the once august body of German learning and subordinated it to Nazism, may be traced largely to the fact that universities in Germany were considered research centers and that teaching was incidental, thus depriving the German youth of a type of education which encourages sensibility to human relationships. "Professors and students were too busy accumulating knowledge to oppose Hitler." Dr. Lilge added: "The research productivity, the results of which are visible enough, was what impressed the outside world, and especially the United States colleges and universities began to rival it. The human void which was the result of this bustling productivity and the moral default which was its price escaped these naive examiners." Dr. Lilge refrains from pointing out parallels, but his book should be a warning to us of what will happen in this country if our colleges and universities fail to appreciate the place of the teacher in developing people who are good as well as scientifically competent, and who have a full appreciation of the importance of good government and a true appreciation of human values

Research is essential and valuable in higher education as long as it has as its main objective the improvement of the main product of an educational institution—the student. Mere experimentation does not take the place of scholarly endeavor, neither does competence in manipulating instruments and gadgets take the place of inspirational teaching which stimulates the learner to clearer thinking and human decency. All good teachers are necessarily scholars and researchers, and are constantly trying to excel in their field through the acquisition of new knowledge. Ordinarily a teacher who is not interested in improving himself through study, research, and writing, who does not contribute to his profession through active participation in scientific and engineering societies and conferences, and who is unknown even in his own field, has little inspirational value and usually lacks ability to improve others. The master teacher must constantly shun intellectual ruts by active participation in research as an aid to effective teaching.

CHARACTERISTICS OF A GOOD TEACHER

What are the characteristics of a good teacher?

It must be recognized that teaching is not only a science, but also an art, perhaps largely an art, and like any art it is individual. Every teacher has his own art. With some, it is mastery of the subject taught; with others, it is a gift for clarity of expression or the power of persuasion. In all cases, however, humanity is a distinguishing characteristic of the great teacher who understands and loves his students as he understands and loves the subject he teaches. This he shows by his keen interest in the individual student, by his kindness and courtesy, by his candor and fairness, by his tolerance and

[1] "What Is Good Teaching?" by H. P. Hammond, *Journal of Engineering Education*, vol. 40, April, 1950, pp. 417–419.

Address presented at the National Applied Mechanics Conference, Purdue University, Lafayette, Ind., June 22–24, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

understanding, and by his optimism and unlimited patience.

Good teaching does not lend itself to large classes, as the teacher in order to practice the art of teaching must know his students, must penetrate beneath the surface, and bring out the best in them, and must at all times adjust his teaching to the preparation and aptitude of the individual student in his class. The teacher must know the individual student in order to recognize possibilities as well as actualities.

Dr. Thomas K. Sherwood, dean of engineering at M.I.T., gives the following as teacher qualifications:[1] "Intellectual capacity; deep interest in students; wide interests outside of his profession; personal traits such as enthusiasm, integrity, fairness, and sympathy; the sense of being articulate and tending to business; and knowledge of the subject he is teaching."

Dr. H. P. Hammond, dean of engineering at the Pennsylvania State College, states it this way:[2]

"A liking for students and the ability to get along with them and to command their respect; the desire and the knack of getting students to do things and to discover things for themselves; and the ambition, backed by inherent capacity to get ahead through development of knowledge, ability, and interest. All of these must, of course, be based on good character, health, and mental capacity."

Unbounded and contagious enthusiasm has always been a principal characteristic of the great teacher, which he radiates in the sparkle of his eye, the vibrance of his voice, his animation, and his vigor.

Intellectual curiosity, good habits of study and of reading are essential qualifications. All good teachers are scholars who endeavor to become masters of the subject they teach.

A teacher must express himself clearly, correctly, and logically. He must talk audibly enough so that he is easily heard; and his enunciation must be such as to be understood readily. His general education, his professional attainments, and his culture must command the respect of his students, academic colleagues, and the public.

A teacher must live up to high ethical standards. He must not condone dishonesty, deceit, trickery, or the evasion of the laws of the land on the part of his students or colleagues. He must have the ability to inspire and instill in his students sound character, worthy ambitions, an insight into right living, an understanding of the meaning of liberty, and an appreciation of human sanctity.

THE INSTITUTION'S ATTITUDE

Institutions of higher learning, to attract the right type of teachers, must realize that even adequate salaries are insufficient unless the attitude of the administration is conducive to the personal development of a teacher. A friendly and appreciative atmosphere is essential to develop the best in most people. Teachers are not hirelings, but are professional people deeply interested in their idealistic calling. All teachers are colleagues. If a teacher is called upon to assume administrative duties, he has a special responsibility to interpret the needs of his staff to his superiors, and to give maximum encouragement and praise where due, to those reporting to him. He is the guardian of the standards and prestige of the university, college, school, division, or department entrusted to his care. He must at all times act as a friend and catalyst who encourages, praises, and inspires his colleagues in their scholarly endeavors.

A teacher in the proper environment, working under an understanding and effective administration and deriving satisfaction from the successes of his colleagues and students, is fortunate in the rewards and pleasures of life which his calling affords him.

[1] "Teacher Qualifications and Development," by T. K. Sherwood, *Journal of Engineering Education*, vol. 39, April, 1949, pp. 412-417.

[2] "How to Recognize and Reward Good Instructors," by H. P. Hammond, *Journal of Engineering Education*, vol. 39, May, 1949, pp. 502-505.

Forest-Products Research

(*Continued from page 808*)

veloped from a 2-man organization to its present position where it now has from 20 to 25 technicians and administrators on its payroll. It has engaged in several hundred projects, most of which have been applied research, but some fundamental research is being conducted.

Scholarships for Technicians. At its last annual meeting the directors of the National Lumber Manufacturers Association made a fund of $1600 available in 1950 for scholarships from the forest schools in the country. These awards have now been given to four graduate students from four different universities. Each successful candidate will be given $400 for his expenses and will be brought to the Teco laboratory for the three summer months of 1950, where he will be trained in industry problems.

Out of the 28 eligible forestry schools to enter this competition, students from 20 schools submitted applications. Through these means we not only intend to help four young men of outstanding ability to obtain positions that will count but we also intend to use whatever influence we have to help the other 16 men acquire similar positions.

Training Courses. In addition to the foregoing, short courses are being taught at the laboratory. One of the great difficulties in the use of modern glues in furniture plants, dimension plants, etc., is the inability and inexperience of most of the firms to do testing. In order to overcome this condition the company has developed low-cost testing equipment which can be afforded by even the smallest concerns. In order to obtain widespread use of the equipment, short courses in gluing have been given at the laboratory once each month for the past half-year. From six to eight students from industry have been accommodated at each course. Hence it is believed that through this means we are able to assist the industry to make technical progress in the field of gluing. It is also believed that firms which send men to these courses will be convinced that trained personnel are necessary. Hence we believe the activity will result in the employment of more engineers and other technicians.

It is planned to conduct schools at the laboratory to assist hardwood manufacturers to cut up and package remanufactured low-grade lumber so that it can be shipped and used more economically.

In addition much of the research work which has been done at the laboratory has been for the manufacturing concerns of the lumber industry. Large programs wherein groups get together to finance research are under way. Progress has been made in developing new products, but one of the greatest difficulties has been to get them into use. This difficulty is being overcome slowly, but the results of research will not gain the desired momentum until we have more trained technical personnel in the industry.

The work at the Teco laboratory is not confined to lumber manufacturers. Furniture manufacturers, adhesive manufacturers or any other concerns or individuals interested in manufacturing wood products or products used with wood can bring their problems to us to be solved. In fact, many of them have done so already. We believe that this work is accomplishing much to further the technical ability of the wood-products industry and the employment of technical personnel.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

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MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Atomic-Weapons Effects

THE atomic bomb is a new weapon of great destructive power. It resembles bombs of the more conventional type in so far as its explosive effect is the result of the very rapid liberation of a large quantity of energy in a relatively small space. But it differs from other bombs in three important respects: First, the amount of energy released by an atomic bomb is a thousand or more times greater than that produced by the most powerful TNT bombs; second, the explosion of the bomb is accompanied by highly penetrating and deleterious invisible rays, in addition to intense heat and light; and third, the substances which remain after the explosion are radioactive, emitting radiations capable of producing harmful consequences in living organisms. It is on account of these differences that the effects of the atomic bomb require special consideration, and are therefore outlined in a new illustrated book entitled "The Effects of Atomic Weapons," which was prepared for and in co-operation with the U. S. Department of Defense and the U. S. Atomic Energy Commission, under the direction of the Los Alamos Scientific Laboratory, Los Alamos, N. Mex. This 456-page book is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at $1.25 per copy.

The book's purpose is to present, as accurately as is possible in the light of present knowledge, a technical summary of the results to be expected from the detonation of atomic weapons. Of necessity, classified information vital to the national security has been omitted.

Throughout the book it is assumed that the effective energy released in the atomic bomb within a short time is roughly equivalent to that produced by the explosion of 20,000 tons of TNT. This corresponds approximately to the energy of the atomic bombs dropped over Japan, which are referred to as a nominal atomic bomb. Since there is a possibility that atomic bombs with different energy equivalents may be developed, scaling laws are given wherever feasible, so that the effects of any bomb of known energy can be calculated from those given for the nominal atomic bomb.

The book supposes, in the first place, that the explosion takes place in the air, i.e., an air burst, at a distance of about 2000 ft above the earth's surface. Some of the special phenomena associated with an underwater burst are also considered.

The fission of the uranium or plutonium in an atomic bomb, it is pointed out, leads to the liberation of a large amount of energy in a very small period of time within a limited space. The resulting extremely high energy density causes the fission products to be raised to a temperature of more than 1,000,000 C. Since this material, at the instant of explosion, is restricted to the region occupied by the original constituents of the bomb, the pressure will also be very considerable, of the order of hundreds of thousands of atmospheres.

SHOCK FROM AIR BURST

The shock wave produced by an air-burst atomic bomb is, from the point of view of weapon delivery and disruptive effect, the most important agent in producing destruction. This implies that the other characteristics of an atomic bomb which can be employed in warfare, such as the presence of thermal and visible radiations, neutrons, gamma rays, and fission products, are, at present, not serious competitors in the production of damage by a bomb which is burst in the air. There are of course other applications, such as the possible use of an atomic weapon as an instrument for radiological warfare by exploding it in a conveniently located body of water, so as to produce a base surge, or in restricting the escape of the fission products by means of a subterranean explosion. The bomb might also be employed to produce earth or water shock through a subsurface explosion.

A reason for the superiority of the air blast as a producer of damage is found in the low air shock pressures (from 2 to 15 psi overpressure) required to damage the majority of man-made structures. Judging from observations made during tests of atomic weapons, it is in fact not very difficult to design atom-bomb-proof structures which will enable life to survive directly below an air-burst bomb set to explode at that altitude, about 2000 ft, which will generally suffice to cause maximum area damage. It is, of course, another matter to redesign cities to withstand these blasts. Because of its primary importance in

How to Obtain Further Information on "Briefing the Record" Items

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For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

atomic warfare, the subject of air blast has received more intensive investigation and, in consequence, is better understood than the other characteristics of a nuclear explosion.

From the formation of the shock wave in an atomic explosion and its propagation it may be noted that the resulting air blast is still strong enough after 10 sec, at about 12,000 ft from the explosion, to break windows, but after 30 sec, at about 36,000 ft, almost all of its energy has been dissipated. The behavior of the shock wave on the ground, during the half minute of its existence and when it exerts its destructive effect, is of great importance for both offensive and defensive purposes.

SHOCK FROM UNDERWATER AND UNDERGROUND BURSTS

The book also gives a qualitative description of the shock phenomena accompanying underwater and underground explosions. The shock wave, responsible for the major amount of the damage resulting from an underwater burst, is described in some detail, and numerical estimates are given of the quantities which are measures of the effectiveness of the shock wave for a nominal atomic bomb. After the explosion, the gaseous products of the detonation reaction are contained in a bubble, possessing considerable energy. As it rises to the surface, it pulsates with the emission of secondary pressure waves, and these waves may contribute to the damage. The motion of the gas bubble subsequent to the emission of the shock wave and surface effects caused by venting of the bubble to the atmosphere are considered.

In the case of an underground explosion, the hot-gas bubble is formed, just as in air and under water, and a shock wave is propagated through the earth. Because of the indefinite nature of the latter, a quantitative treatment is much more difficult than for the other types of explosion. However, there are probably some resemblances between an underground atomic-bomb burst and an earthquake which permit useful conclusions to be drawn. In addition, a certain amount of information has been obtained from direct experiments with conventional explosives.

AIR-BLAST DAMAGE IN JAPAN

The actual effects on buildings, bridges, utilities, and housing to be expected from the detonation of a nominal atomic bomb, based on information obtained from surveys of Nagasaki and Hiroshima, are also considered in the book. References are made to structures of types that were not found in the blasted areas of these cities. In addition, differences in construction practice, which affect the comparison to be made between Japan and the United States, are taken into account.

From the observations made in Japan, the blast damages to be expected at various distances from ground zero for an air burst of a nominal atomic bomb are as follows:

Virtually complete destruction will occur to a radius of approximately one half mile from ground zero, corresponding to an area of destruction of about three quarters of a square mile.

Severe damage, defined as major structural damage that would result in collapse or liability to collapse of a building, will occur to a radial distance which is slightly in excess of one mile from ground zero. This corresponds to an area of 4 square miles in which the damage ranges from severe to destructive.

Moderate damage, short of major structural damage but sufficient to render the structure unusable until repaired, will occur to a radius of about 1⅝ miles, giving an area of 8 square miles in which the damage ranges from moderate to destructive.

Partial damage will be inflicted to a radius of approximately 2 miles, adding 4 additional square miles of damage area, and making a total of 12 square miles subjected to some degree of damage in excess of plaster damage and window destruction.

Light damage, which is mostly plaster damage and window breakage, may extend to a radius of 8 miles or more, giving a light-damage area of the order of 200 square miles.

PROBABLE EFFECTS IN THE UNITED STATES

While the destructive effects observed in Japan are comparable, in general, to those to be expected in the United States, there are some differences. Furthermore, there is the question of damage to the larger bridges of many American cities for which there is no direct guide from damage to the small bridges in Japan. Reinforced-concrete buildings of earthquake resistant design withstood the blast quite well. These buildings were designed for a lateral force equal to 10 per cent of the vertical load. When pressure is applied tending to displace the top of the building with respect to the foundation, the resulting action is roughly the same as that which would arise if seismic forces moved the foundation against the inertial resistance of the structure.

The multistory buildings in this country are generally designed to withstand a wind load of 15 lb per sq ft. For an average six-story reinforced-concrete frame building this would be roughly equivalent to 2 per cent of the vertical load. On this basis, American reinforced-concrete buildings would be much less resistant to collapse than those designed for earthquake resistance in Japan. No firm conclusions can be drawn on this subject, however, as most buildings have lateral strength far in excess of that required to withstand a 15-lb per sq ft wind load.

The effect on steel-frame buildings, such as multiple-storied office and hospital structures, should be approximately the same as that on reinforced-concrete buildings, except that steel has a somewhat greater energy-absorption capacity than reinforced concrete. This is due to the fact that with usual design stresses the work necessary to produce failure in steel is greater in proportion than in reinforced concrete. Consequently, tall buildings having heavy steel frames, constructed so as to provide good continuity at connections, and a long period of vibration, should withstand the effect of blast quite well.

American steel industrial buildings would probably fare no better than those in Japan. The sawtooth roofs designed as rigid frames would be especially vulnerable to blast damage.

In Japan, bridges withstood vertical blast loads quite well, and there is no reason to believe that other bridges of the same type would not behave in a similar fashion. In fact, it is probable that all bridges would be quite resistant to blast. Lateral loads, even if excessive, would affect the less important structural members of the bridge.

AIR BURSTS OVER AND UNDER WATER

From the data obtained in the Bikini ("Able") air burst over water it appears that, allowing for the difference in the height of burst, the variation of the peak pressure of the shock wave with the horizontal distance from the point of burst is similar to that found for an air burst over land. Consequently, it may be concluded that the general nature of the damage to houses and other buildings and installations on shore, at specific distances from the bomb burst will be much the same.

The evidence from the Bikini ("Baker") shallow underwater atomic explosion is that the shock wave transmitted through the water was the major cause of damage to the ships in the lagoon.

It is expected that the lethal or sinking range of all types of surface vessels will be very much the same, and will be in the neighborhood of 1200 to 1800 ft from surface zero, for a shallow underwater burst of a nominal atomic bomb. Some ships will

probably be sunk out to 2700 ft, but others in this range will suffer considerable structural damage. Serious loss of efficiency is to be anticipated within a radius of 3600 ft from surface zero. Even at this distance the peak pressure of the underwater shock wave will be over 500 psi. Submerged submarines will probably be lost out to 2700 feet from the explosion.

THERMAL RADIATION EFFECTS

Radiations from an atomic explosion may be divided into two major categories, thermal and nuclear radiations.

An atomic bomb, for example, releases roughly one third of its total energy in the form of this radiation.

The proportion of the thermal radiation emitted in a particular atomic explosion that reaches the earth's surface depends on the distance from the burst and the clarity of the atmosphere.

It has been estimated, for example, that in the atomic-bomb explosions in Japan, which took place some 2000 ft above the surface of the earth, the temperature at ground zero, due to thermal radiation, was probably between 3000 and 4000 C. It is true that the temperature fell off rapidly with increasing distance from the burst, but the effects were definitely noticeable as far as 2 miles away or more.

The most important physical effects of the high temperatures due to the absorption of thermal radiation are, of course, ignition or charring of combustible materials and the burning of skin.

Exposure to thermal radiation from a nominal atomic bomb, on a fairly clear day, would lead to more or less serious skin burns within a radius of about 10,000 ft from ground zero. Since the rays travel in straight lines, only direct exposure in the open or through windows would lead to harmful consequences. Therefore, shelter behind almost any object, such as anywhere in the interior of a house, away from windows, of course, or behind a tree, or even protection of one part of the body by another so as to avoid direct exposure, would be effective.

NUCLEAR RADIATION EFFECTS

The explosion of an atomic bomb is also accompanied by the emission of nuclear radiations, consisting of gamma rays, neutrons, beta particles (electrons), and a small proportion of alpha particles. The neutrons and some of the gamma rays are emitted in the actual fission process, that is to say, simultaneously with the explosion, while the remainder of the gamma radiation and the beta particles are liberated as the fission products decay. The alpha particles result from the normal radioactive decay of the plutonium 239 or uranium 235 which has not undergone fission.

Both gamma rays and neutrons can produce harmful effects on living organisms.

Shielding from thermal radiation, at distances not too close to the explosion of the bomb, is a relatively simpler matter, but this is not true for gamma rays or neutrons. For example, at a distance of 3000 ft from the explosion of a nominal atomic bomb, the initial nuclear radiation would probably prove fatal to 50 per cent of human beings, even if protected by 12 in. of concrete, although a much lighter shield would be adequate against the thermal radiation. However, beyond about 7000 ft, the nuclear radiations would be virtually harmless, without protective shielding, whereas exposure to the thermal radiation at this distance could produce serious skin burns in the same circumstances.

RESIDUAL RADIATIONS

The residual nuclear radiations, that is to say, those which are emitted after 1 minute from the instant of an atomic explosion, would arise mainly from the fission products, to a lesser extent from the uranium 235 or plutonium 239 which has escaped fission in the atomic explosion, and, in certain circumstances, from activity induced by neutrons in various elements present in the earth or in the sea. Any of the radioactive material which is dispersed in and considerably diluted by the atmosphere may be ignored. But that reaching the inhabited surface of the earth in appreciable amounts may represent a serious physiological hazard.

A human being receiving a total of 400 Roentgen of the initial nuclear radiation, that is, over a period of a minute or so, would have a 50 per cent chance of survival, but, if the same amount of radiation was absorbed over a period of a month, the probability of death would be considerably less.

Fears have been expressed in some quarters concerning the danger of world-wide contamination by radioactivity resulting from atomic explosions. That such fears are groundless can be shown by estimating the number of bombs which would have to be detonated to produce enough activity to cover the earth.

If the whole surface of the earth is to be contaminated, with a minimum number of bombs, they would have to be exploded within a short period of time. Further, since contamination from fission products would be due essentially to the fall-out, sufficient time must be allowed for all the particles to settle out. On the basis of these postulates, it has been calculated that in order to constitute a world-wide hazard, something like a million atomic bombs, of the nominal size, would have to be detonated, roughly, one to each 200 sq miles of the earth's surface.

World-wide radioactive contamination would thus appear to be extremely unlikely, but local contamination due to a relatively small number of bombs might be a serious problem over a large area.

RADIOACTIVE CONTAMINATION

The relative importance of the sources of radioactive contamination following an air burst will depend on a variety of circumstances, for example, the nature of the terrain and the meteorological conditions.

Of the types of atomic explosion, the underwater burst at Bikini, that is, the Baker test, produced by far the greatest degree of radioactive contamination. It was estimated that almost all of the fission-product activity either remained in the water immediately following the detonation, or fell back into the lagoon in the form of the radioactive base surge and rain.

It is evident that, although a ship would not wish to remain in the contaminated area for any length of time soon after the explosion, passage across the water would not be a great hazard. Further, because of the decrease in activity with time, it seems unlikely that an underwater burst of an atomic bomb would prevent operation of a harbor for any length of time, at least as far as contamination of the water is concerned.

RADIOLOGICAL WARFARE

An extreme case of contamination by radioactive isotopes would arise if such substances were used deliberately as an offensive weapon. This possibility is generally referred to as radiological warfare, the term being used to describe the employment for military purposes of radioactive material with the object of contaminating persons, objects, or areas. The atomic bomb may be described as an indirect weapon of radiological warfare, for its main purpose is to cause physical destruction, the radioactive contamination being a secondary consideration.

It is pointed out, however, that it would not be easy to produce large amounts of radioactive isotopes for radiological warfare. Under favorable conditions, a nuclear reactor oper-

ating for 100 days with a power output of a million watts would produce something of the order of a megacurie of activity. If this were spread out uniformly over a plane surface having an area of 1 square mile, the dosage rate 3 ft above the surface would be only 200 R per day for a 1.5 Mev gamma ray. This rate would, of course, fall off with time, depending on the half-life of the contaminating material.

The caustic effect of beta-emitters on the skin might represent an important hazard, but this alone would hardly warrant employment of a pure beta-active substance as an offensive weapon. Nevertheless, it would represent an additional source of injury when a gamma-emitter is used.

On the whole, it is concluded that if radiological warfare is used as a weapon, it will be in the form of emitters of penetrating gamma radiation for which protective clothing and gas masks would be ineffective. With such substances it would be easier, than in the other cases, to achieve a level of radiation that would be lethal as the result of an appreciable exposure. However, it would appear to be a difficult matter to lay down such a concentration of gamma-emitters over a large area as would cause serious injury from a short exposure.

DECONTAMINATION

There are essentially three ways whereby the hazard associated with radioactive contamination may be minimized: First, to dispose completely of the material by deep burial in the ground or at sea; second, to keep it at a distance for a sufficient time to permit the radioactivity to decay to a reasonably safe level; and third, to attempt to remove the contaminant, that is, to decontaminate the material. These three procedures were used, in one way or another, in connection with radioactive contamination suffered by ships and their equipment after the Bikini Baker test.

At Bikini the U.S.S. *Independence*, a small aircraft carrier received such a large radiation dosage that had there been any personnel on the hangar deck at the time they would have succumbed from external radiation, apart from the effects of the blast. Yet 2 weeks after the detonation the dosage rate was about 3 R per day, permitting short-time access. About a year later, the average dosage rate was only 0.3 R per day, and 3 years after the original contamination the *Independence* was in use at the San Francisco Naval Shipyard, where she housed the experimental engineering group of the Naval Radiological Defense Laboratory. It was difficult at that time to find any areas on the ship where the radiation dosage would have exceeded the limit of 0.3 R per week adopted in installations of the Atomic Energy Commission.

The actual process of decontaminating material and equipment can be resolved into two stages: first, immediate emergency measures, so as to permit continued operation; and second, final decontamination operations of a more thorough nature.

Normally, clothing will prevent access of the material to the skin. When contaminated, clothing should be removed and disposed of, by burial for example, in such a manner as to prevent the spread of the radioactivity.

Attention must be paid to cleansing any exposed surfaces of the body. A fair degree of decontamination of the exposed skin can be achieved by vigorous rubbing with soap and water, paying particular attention to the hair, nails, skin folds, and areas surrounding body openings, and with due care to avoid abrasion. Certain synthetic detergents, such as soapless household cleansers, have been found to be especially effective.

If the soap-and-water treatment does not produce the desired decrease in activity, chemical agents, if available, may be used on the skin. Isotonic saline of pH 2, or depilatory or keratolytic agents, such as a mixture of barium sulphide and starch, will lead to the removal of material held tenaciously by the skin. A dilute solution of sodium bicarbonate is useful, especially on mucous membranes, because of its action as a complexing agent for some of the fission products.

For the emergency decontamination of inanimate objects, household cleaning and scouring compounds, grease removers, detergents, paint cleaners, dry-cleaning solvents, gasoline, etc., will be helpful.

Exposed surfaces, especially in cities, are usually covered with an "industrial film" of grease and dirt. It has been observed, in many instances, that radioactive contamination attaches itself primarily to this film and that its removal consequently affects considerable decontamination. Special cleaning methods for the removal of industrial film have been developed; an example is the use of live steam, into which is fed a concentrated solution of a detergent, for cleaning airplanes.

Methods employing abrasion are perhaps the most effective; wet sandblasting, for example, was used successfully in decontaminating large areas of the Bikini target vessels.

Abrasives less radical than sand, which effect removal of only a thin surface layer, have also been used. Soft materials like sawdust and other substances of a similar nature, have been suggested for the decontamination of delicate articles such as instruments or bearing surfaces that would be injured by sand. Similarly, scrubbing may be used for the removal of a thin outer layer. Steel wool, wire brushes, floor polishers, or various buffing or polishing machines, can be adapted to decontamination by surface removal in various circumstances.

Chemical means can also be applied to remove the surface and with it the contaminating radioactivity.

In the event of serious radioactive contamination of a large part of a city, the most important matter would appear to be the removal or coverage of loose material which might form dust that would be inhaled or ingested with food. For paved streets, flushing, perhaps with the aid of detergents, street cleaning, or vacuum sweeping, if feasible, might be the first steps. If the contaminant is on the surface or has not penetrated too deeply, concrete, stone, and brick buildings would perhaps have to be wet-sandblasted and reroofed. Painted wooden structures might be easily decontaminated, but stucco buildings might have to be removed.

Properly covered foods should undergo little or no contamination. The same will be true of canned goods or any materials in impervious dustproof wrappings. There appears to be no feasible means for salvaging unprotected food.

If the degree of contamination of water is not too severe, then it is probable that as a result of the operation of several factors, e.g., dilution by flow, natural decay, adsorption, etc., the water will not usually be rendered unfit for consumption, except perhaps for a limited time immediately following the contamination.

It was found at Bikini, for example, that contaminated water when distilled was perfectly safe for drinking purposes. However, mere boiling of water contaminated with radioactivity is of no value.

The ideal defense against radioactive contamination is to use, wherever possible, surfaces which are either resistant to such contamination or from which the active material can be readily removed. It has been found, for example, that surfaces coated with certain plastic paints are relatively easily decontaminated. There are indications at present that certain materials, such as polyethylene, have these desirable properties, and these substances could be used to form thin surface layers on various articles of equipment.

Structural materials, e.g., concrete, brick, and soft woods, present a special problem, since decontamination of porous substances is virtually impossible.

Another possibility in connection with protection against radioactive contamination which has been found successful in laboratories handling high levels of activity, is to use plastic strippable coatings. In the event of radioactive contamination, the plastic surface is stripped off and replaced with a new one.

Where the foregoing procedures are not possible, vital equipment may be kept under cover by means of tarpaulins or other movable protection.

EFFECTS ON PERSONNEL

It is estimated that at least 50 per cent of the fatal casualties due to the atomic bombings of Japan were caused by burns of one kind or another. Many people who were injured by blast were also burned. Within about 2500 ft of the center of the explosion, it is probable that blast, burns, and radiation could separately have been lethal in many cases. It should be pointed out, however, that not everyone within the 2500-ft radius from the center of burst was killed. Among those who survived the immediate results of the explosions at Hiroshima and Nagasaki, a number died later from what was ascribed to radiation sickness; these were believed to represent from 5 to 15 per cent of the total number of fatal casualties.

In the case of a high air burst, such as at Hiroshima and Nagasaki, most of the casualties will be due to burns and blast effects.

An explosion at low altitude or at ground level would produce somewhat fewer casualties from blast or burns, but a small area would be highly contaminated with radioactive material.

After a shallow underwater burst the number of casualties from blast and burns will also be diminished. However, some casualties might arise from exposure to the radiation from fission products and, to a lesser extent, material which has escaped fission, spread over an appreciable area by the basic surge and the fall-out.

PROTECTION OF PERSONNEL

As far as burning caused by thermal radiation is concerned, the essential points are protection from direct exposure for human beings and the avoidance of easily combustible materials, especially near windows. The only known defense against the gamma rays and neutrons constituting the initial nuclear radiation is the interposition of a sufficient mass of material between the individual and the atomic bomb. The use of concrete as a construction material, which is necessary to reduce air-blast and ground-shock damage, will, to a great extent, decrease the initial radiation hazard.

From the standpoint of physical damage, the problems of construction and protection from atomic bombs are not fundamentally different from those associated with bombs of the conventional type.

PROTECTION AGAINST DAMAGE

If buildings must be constructed in possible target areas for an atomic-bomb attack, they should be designed so as to increase the safety of occupants and offer the greatest practical resistance to collapse and damage. Any building to be constructed within three miles of a vital target should be considered as being within the target area, although the degree of protection aimed at in the design would be governed by the location of the building in the area. In addition, consideration may be given to the importance, in the event of an emergency, of the industry or activity carried on in the building.

With regard to rigidity, it is believed that the general solution of the problem of design of a building to resist high lateral and downward pressures lies in the provision of additional resisting elements such as transverse shear walls, lateral beams, and deep lateral trusses, and in the design of concrete floors and roofs to transmit the lateral forces to vertical shear walls. In bending due to frame action, the conventional use of columns as the resisting elements is unsatisfactory for high lateral forces. The establishment of design requirements for a static wind load is largely arbitrary, but is useful in providing a criterion to which design may be directed. It will be beneficial to include any design feature that will provide greater strength where cost is not materially increased. It will also be found that limiting the height of buildings is desirable in order to avoid high lateral stresses.

Aside from the question of the design of new construction, changes must be made in existing buildings so as to reduce the hazard due to blast damage. The most serious danger to persons and equipment in a building is from total collapse. It is believed that adding bracing and shoring or new transverse reinforced-concrete walls will, in general, be more feasible than strengthening the frame.

Blast walls of the type provided to localize damage from ordinary bombs will be helpful in reducing injury from flying missiles and will afford some protection against atomic blast. Similarly, walls around essential equipment, such as transformers, will be effective in reducing damage. These walls should be of reinforced concrete 12 in. thick and should be made resistant to overturning.

In an underground explosion, there would be almost complete destruction within the crater area. Beyond that area there would be earth-shock effects that are roughly comparable to those of an earthquake.

In the event of an underwater atomic explosion taking place close to the shore, the actual harbor works are expected to suffer some damage. The blast effect on shore installations, warehouses, etc., must, of course, be taken into consideration, but the problems are essentially the same as those for an air-burst.

One of the most important lessons learned from the atomic-bomb attacks on Japan is the necessity for the provision of an adequate water supply for the control of fires.

ESSENTIAL DISASTER FACILITIES

Facilities for the direction of disaster-relief activities and provision of first aid in a city, require a protected area on one of the lower floors of a well-constructed, fireproof, reinforced-concrete, or steel-frame building. To avoid the hazard of a general conflagration, the building should not be situated among others that are not fireproof. The protection provided should be such as to assure reasonable safety against blast and radiation injury at a distance of roughly half a mile from an atomic explosion. A total thickness of about 2 ft of concrete would be required for this purpose, and in a concrete building this could probably be achieved by enclosing an area with a 12-in. reinforced-concrete wall anchored to the floor to prevent displacement, and braced or secured at the top to avoid overturning.

Tentatively, shelters may be designed for a static load of 500 lb per sq ft, with usual design stresses to provide an adequate factor of safety.

The most effective method for providing adequate ventilation is to use a pressurized installation in which the air is forced through special air filters which will remove radioactively contaminated particles.

EMERGENCY SHELTER

In the event of a surprise atomic explosion immediate action could mean the difference between life and death. The first indication of an unexpected atomic burst would be a sudden

increase of the general illumination. It would then be imperative to avoid the instinctive tendency to look at the source of this light, but rather to do everything possible to cover all exposed parts of the body.

If a person is in the open when the sudden illumination is apparent, then the best plan is instantaneously to drop to the ground, while curling up so as to shade the bare arms and hands, neck, and face with the clothed body. Although this will not protect against gamma rays, it may help in reducing flash burns. This is important since disabling burns can be suffered well beyond the lethal range for gamma rays. The curled-up position should be held for at least 10 sec; the immediate danger is then over, and it is permissible to stand up and look around to see what action appears advisable.

If in the street, and some sort of protection, such as a doorway, a corner, or a tree is within a step or two, then shelter may be taken there with the back to the light, and in a crouched position to provide maximum protection. No attempt should be made to reach a shelter if it is several steps off; the best plan then is to crouch on the ground, as if completely in the open. After 10 sec, at least, a standing position may be resumed, but it is strongly advisable to press the body tightly against the side of a building to avoid breaking glass or falling missiles, in so far as possible.

A person who is inside a building or home when a sudden atomic-bomb attack occurs should drop to the floor, with the back to the window, or crawl behind or beneath a table, desk, counter, etc.; this will also provide a shield against splintered glass due to the blast wave. The latter may reach the building some time after the danger from radiation has passed, and so windows should be avoided for about a minute, since the shock wave continues for some time after the explosion. The safest places inside a building are the interior partitions, and it is desirable to keep as close to these as possible.

PROTECTION FROM RESIDUAL RADIATIONS

Personnel entering a contaminated area, whether to perform monitoring or other emergency work, should wear protective clothing of some kind. Actually, ordinary clothing is adequate protection against alpha and beta radiation, but since it is likely to become contaminated it would have to be destroyed.

Soon after an atomic explosion there is likely to be a large amount of dust in the air, especially in the regions of appreciable destruction. There is practically no danger in this dust being contaminated after a high air burst. However, other types of deliveries could spread radioactivity on the ground. Consequently, all members of emergency teams entering a contaminated area should wear respirators. Masks covering the nose and mouth, of the type developed as a protection against chemical-warfare agents, have been found to be satisfactory in preventing the inhalation of dust particles. Where the amount of dust is very large, it might be necessary to use a respirator hood to give complete protection of the head.

CONCLUSION

The purpose of this AEC book from which the foregoing information has been taken is to provide the essential scientific and technical information that will permit the necessary plans to be made for dealing with the new and unusual situations that would arise as the result of the explosion of an atomic bomb. The organization, preparation, and techniques designed to deal with these situations involve considerations beyond the scope of this book. Their precise nature depends upon many factors which must be evaluated nationally, and their application will vary with the patterns of regional and community development.

Gas-Turbine Production

LARGE-SCALE production of gas-turbine power plants for land, railroad, and marine use, has been started by the General Electric Company in Schenectady, N. Y., plant facilities now being equipped at a cost in excess of $4,000,000.

Glenn B. Warren, Mem. ASME, manager of the company's Turbine Divisions, announced that "accelerated production" has begun on the first few of more than 20 gas turbines scheduled to be built within the next two years for power generation and for gas pipe-line pumping stations.

Technological advances during the last 12 years and the successful operation of units now installed indicate the gas turbine is ready to assume a significant role in the power field, along with steam and mercury power plants, Mr. Warren said.

He stated that further advances will find the gas turbine an effective tool, when properly applied, for still further reducing the cost of power.

Units are now being built in a factory building containing 250,000 sq ft of floor space. He pointed out that the building, in which modern manufacturing and test equipment is now being installed, will be in full-scale production within eight months.

Gas turbines now scheduled for production, he said, will be in three basic models:

A 3500-kw (4800-hp) simple-cycle type, similar to three units now operating—one for a southwestern utility company, one for a New England power company, and the other in a gas-turbine-electric locomotive; a 5000-kw two-shaft compound-cycle type for power-generation use; and a newly designed 5000-hp two-shaft mechanical-drive type for gas pipe-line pumping and other applications. This, according to Mr. Warren, will be a more efficient machine than the 3500-kw simple-cycle machine. A unit of this type with a 4000-kw generator has been sold to an electric utility for power generation.

Other sizes and types will be put into production as the gas-turbine program develops.

Microrocket

A SO-CALLED "microrocket" motor small enough to hold in your fist is helping chemical engineers at the Massachusetts Institute of Technology, Cambridge, Mass., develop fuels for full-size rocket-powered missiles.

This tiny liquid-fuel rocket motor is believed to be the smallest of its type in the world. By running on very small amounts of fuel and by eliminating the need for elaborate safety precautions, it makes possible experiments costing far less than full-scale tests.

Already the results have brought about a more complete understanding of rocket fuel combustion. Future work will continue to fill in this picture and is also expected to provide answers to specific rocket design problems.

The microrocket fuel testing is part of a comprehensive project now under way at M.I.T. under the auspices of the U. S. Navy Bureau of Ordnance and Office of Naval Research.

The M.I.T. microrocket uses only two pounds of fuel in the one minute during which 12 tons would be used in a rocket the size of a German V-2. The microrocket operates on exactly the same principle and with the same high efficiency as its larger prototypes—but on a greatly reduced scale.

Although built to use any liquid rocket fuels, the microrocket has to date been used chiefly with a combination of liquids which ignite spontaneously on contact. When they

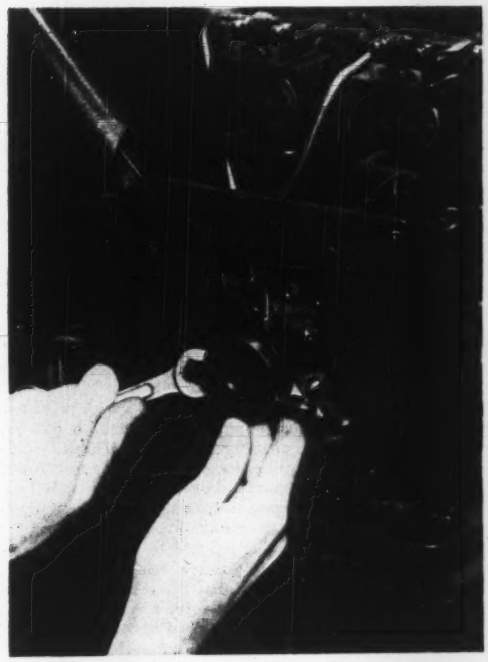


FIG. 1 MICROROCKET MOTOR HELPS TO DEVELOP BETTER ROCKET FUELS

come together inside a rocket motor, the resulting flame makes a tremendous amount of heat and therefore power.

Though a toy in size, the M.I.T. microrocket is hardly a living-room plaything. On two pounds of fuel it runs for one minute, builds up more than 300 lb of pressure inside the motor, shoots gas out its nozzle at a speed of about 5000 mph, more than 2½ times the velocity of sound at these conditions, and produces heat at the same rate as does a furnace big enough to heat an eight-room house.

Jets of the microrocket fuels, shot through 0.01-in-diam holes, come together inside the chamber which is only ½ in. in diam. Heat is produced with the same efficiency as in full-size rockets.

It is reported that this experimental work on a reduced scale materially lessens the cost of fuel and other materials and reduces the safety precautions required. It becomes imperative when testing new fuels which are scarce or difficult to prepare.

Recent studies have investigated rocket operation at simulated high altitudes, where low air pressure may be combined with low temperature. To date two questions have been answered:

1 When the liquids come together at low temperatures such as would be encountered at high altitudes, what can be done to make sure they will still fire to give a quick start? If combustion is delayed, fuel will accumulate inside the rocket engine and the resulting explosion, when the mixture does take hold, may be enough to blow the engine apart.

2 An antifreeze must be added to the chemicals if the rocket is to be used at low temperatures; what compounds will best serve this purpose without affecting other performance operating characteristics?

To help answer these questions the microrocket—and its fuel—are refrigerated. Then as combustion gets under way the pressure developed inside the rocket motor cavity is continuously recorded.

At 40 deg ignition may take many times as long as at ordinary room temperatures. In a rocket to be launched at high altitude, this delay might be serious. The addition of certain chemicals to the fuel mixture can reduce this ignition time.

The use of an antifreeze in one of the two fuel compounds also increases ignition time unless compensating changes in the formula are made.

Studies of the microrocket operating at low air pressures will be the next step in the M.I.T. program. Because of the large quantities of gas generated by a rocket, making such tests with a large unit at low pressure would require gigantic vacuum pumps; hundreds or even thousands horsepower might be required to drive them.

Eventually, microrocket operation at both low temperature and pressure will be investigated.

Earlier tests which evaluated the success of the microrocket were made at room temperatures, with special equipment to measure the rocket's power, the pressures inside the engine, and the heat generated for a given amount of fuel consumption.

In addition to its advantages in economy and ease of operation, the microrocket makes possible performance measurements of equal accuracy to those obtained with larger-scale testing, according to the M.I.T. engineers. Other instrumentation problems, too, are simplified.

Turboprop Attack Plane

A POWERFUL new Navy carrier-type attack plane, designed to combine the high speed of jet propulsion with the fast take-off performance of conventional propeller-driven aircraft, is undergoing initial flight tests at the Douglas El Segundo, Calif., plant, according to the Cado *Technical Data Digest*, August 1, 1950.

Designated the XA2D and named the "Skyshark," the plane was built for the Navy by Douglas.

The Skyshark's 5500-hp twin-turbine engine, built for the Navy by the Allison Division of General Motors, develops more horsepower on take-off than any other U. S. engine now being flown.

Equipped with folding wings and tail-hook assembly for carrier operation, the Skyshark may be armed with a variety of air-borne weapons, including rockets, bombs, and aerial torpedoes slung from wing racks.

The T-40 turboprop engine combines two complete and separate power units, which connect with a common reduction-gear box that, in turn, is connected with the shafts for the three-bladed contrarotating propellers.

One of the outstanding advantages of the T-40 engine is that for normal cruising the engine can operate on one of the twin turbines alone, thus increasing the range of the aircraft while carrying a power reserve for emergencies. The contrarotating propellers eliminate torque during full-power take-off and landing operations.

Another feature of the engine is the fact that its weight per horsepower is less than one half that of the conventional reciprocating engine. The total plane plus pay load is considerably more than that which could be lifted by any reciprocating engine of the same weight.

The T-40 is rated at 5500 hp for take-off. Also, either power

section may be operated independent of the other, and for cruising one unit may be cut out for the most economical use of fuel. Weight of the engine with extension shafting and reduction gear is less than 2500 lb.

Transport Aircraft

A NEW U. S. Air Force transport plane, the XC-120, with a detachable fuselage, made its first flight recently from the Fairchild Aircraft Division airport.

The transport is said to pioneer an entirely new concept of air transportation and is expected to offer the first real answer to many of the most pressing problems of military logistics.

In appearance, it resembles the Fairchild C-119 Packet—except that its fuselage is detachable from the remainder of the plane. The plane itself—engines, cockpit, booms, and tail surfaces—is able to fly without the fuselage, much as the cab of a trailer truck is driven minus its trailer.

Thus the chief advantage of the pack plane is that it eliminates the long, expensive periods on the ground while cargo is being unloaded, or loaded, as is necessary with present-day transport planes. A pack plane can fly into a field, have its fuselage, or "pod," almost instantly detached, and be ready to take off to pick up another fuselage within a matter of minutes. In addition to providing greater utility of the plane itself, this reduced ground time limits the potential damage in case of wartime attack to the relatively inexpensive fuselage compartments.

Once it is on the ground and detached from the plane, the XC-120's fuselage can be unloaded at the most convenient time for ground crews, then reloaded and stored until it is ready to be picked up by another plane. It has both front and rear clamshell doors which open the entire cargo compartment for quick direct loading.

As an alternative to unloading the pods, they themselves can consist of built-in units—hospitals, machine shops, operations control towers, communications centers, offices, etc.—and be ready for full-scale use as soon as they land. This is a phase that is becoming increasingly interesting to military planners and a number of different pod applications are already under consideration.

Powered by two 3250-hp Pratt & Whitney engines, the XC-120 will have basically the same operating characteristics as the Fairchild C-119. Its detachable cargo compartment has a 2700-cu-ft capacity and can carry up to 20,000 lb of cargo. Fully loaded, the entire plane weighs about 64 000 lb and carries a crew of five.

FIG. 2 U. S. AIR FORCE TRANSPORT PLANE WITH DETACHABLE FUSELAGE

Reheat Boiler

A REHEAT boiler, said to be the world's largest, to generate steam for electricity has been purchased by Consolidated Edison Company from The Babcock & Wilcox Company, it was announced recently. It was also revealed that the utility company would build a new station in Astoria, Queens, to house the giant boiler and other related equipment for generating electricity, and that the first unit installed would cost $25,000,000. The new station and equipment is a part of Consolidated Edison's half-billion-dollar expansion program and is the first new station to be built by the company since 1926.

Babcock & Wilcox engineers point out that the new boiler will be as high as a 14-story building and will produce 1,200,000 lb of steam per hr or sufficient to generate electricity for a city of 400,000 people. It will be built in the company's plants in Barberton and Alliance, Ohio, and Beaver Falls, Pa., shipped here in sections, and assembled like a prefabricated skyscraper at the site.

The mammoth boiler will initially burn oil with provision for future installation of coal-burning equipment. It will develop steam temperatures of 1000 F. The water is heated while circulating through nearly 65 miles of tubes varying from 2 to 5 in. in diam, which will be supplied by The Babcock & Wilcox Tube Company. It is designed to burn about 10,000 gal of oil per hr or enough to heat an average five-room home for 10 years.

B&W engineers explain that the new reheat boiler differs from the conventional boiler in that the steam at 1000 F, a point of high efficiency, is used to drive a turbine and then, when the steam temperature has dropped to 650 F, but before condensation, it is returned to the boiler to be reheated and used to drive a second turbine. The efficiencies of this system will reduce a fuel bill five per cent under that of conventional systems, while giving the same performance, the engineers say.

Self-Locking Pin

A SELF-LOCKING pin with chamfered ends, called a Rollpin, has been designed by the Elastic Stop Nut Corporation of America, Union, N. J., to replace the variety of dowel, pivot, tapered, and grooved pins, which ordinarily require a key or some supplementary fastening method to hold them in place.

The Rollpin is made of SAE 1045 steel or type 420 stainless steel, and is rolled into the shape of a cylinder with a gap or slot which parallels the long axis of the hollow cylinder. Both ends of the cylinder are chamfered, or beveled, so the pin can be driven and compressed into a hole that is, by design, smaller than the diameter of the pin. The slot permits compression of the cylinder as the pin is driven in, and, according to ESNA, the resulting tension, caused by the constant pressure exerted by the Rollpin against the walls of the hole, secures it in position even against extreme vibration and shock.

The predecessor of the Rollpin made its first appearance in 1942, when United States military personnel found a "rolled pin" holding together the bolt-head assembly of a German aircraft cannon.

Attracted by this ingenious device, military specialists tried to duplicate the bolt assembly, but found they could not do so without the rolled pin. In the assembly, the pin held the parts together securely, did not extend beyond the hole in which it operated as a fastener, and did not move in the hole under severe vibration. These characteristics were of extreme in-

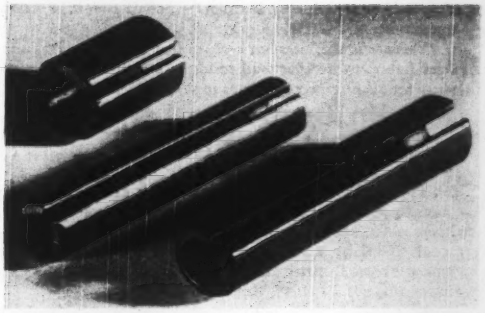


FIG. 3 CLOSE-UP VIEW OF THREE SIZES OF THE ROLLPIN

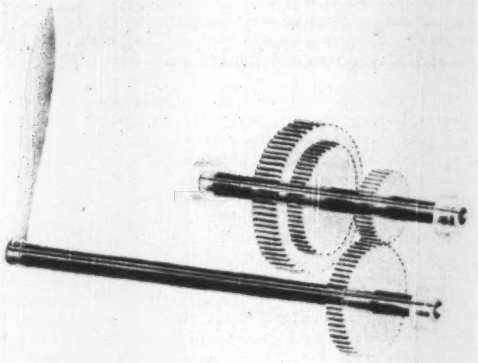


FIG. 4 ROLLPINS ARE SHOWN HERE USED AS SHAFTS FOR ASSEMBLY OF GEAR TRAINS ON A METERING DEVICE

terest to technicians, who also discovered that in this particular design there was no need to use an additional fastener to hold the pin in place.

Later, Army specialists found that other captured German equipment, such as portable antiaircraft range and direction-finding units, had cams and followers fastened with this type of pin. These units were tested, and in further experimentation, specialists replaced the German-type pin with a dowel pin, but immediately found that the accuracy of the equipment was affected. Conversely, dowel pins in similar items of United States equipment were replaced with the rolled pins with noticeable improvement in accuracy.

Technicians found out that this improved accuracy was attributable to the rolled pin's ability to take up backlash, as the tension on the device kept it in alignment even with severe vibration, provided the operating load on the pin was less than the deflection load limit.

The slotted cylindrical design of the Rollpin affords a high-pressure, shakeproof grip in holes drilled to normal production tolerances, thereby eliminating expensive hole-reaming operations. The pin is re-usable without impairing locking efficiency, and without redrilling holes, or substituting a larger-size pin. The shear strength of the pin is said to exceed that of cold-rolled pins of equal diameters. Simple, rapid insertion is possible with hand tools or automatic jig assemblies, and removal is easily accomplished with a drift pin or pin punch.

In typical applications, the new fasteners can be used as shafts for an assembly of gear trains, such as those on a metering device. Or, for example, a single Rollpin can replace a pivot pin or bolt on solenoid relay devices.

At present Rollpins are made in 13 diameters to fit hole sizes ranging from 0.078 or $^{5}/_{64}$-in. to 0.500 or $^{1}/_{2}$-in. and a Rollpin of specific diameter may be obtained in a wide range of stock lengths.

Air-Pollution Control

STEEL companies have been helping to lessen air pollution in their communities for some time. Now a new attack on the problem has been launched by the Industrial Hygiene Foundation of America under the sponsorship of the American Iron and Steel Institute.

Steel companies will make their data and equipment available to scientists from the Foundation. New methods and devices for collecting samples of air will also be put to work. The program calls for an expenditure of $20,000 within six months to study steel-mill processes and atmospheric conditions surrounding many plants. The results of this preliminary research will determine whether a concerted effort by the steel industry in developing air-pollution control is needed, and if so, along what lines.

Steel companies have undertaken air-pollution control individually and in groups for a number of years. Many of the problems involved vary with local weather conditions, geography, and products manufactured.

Among the first problems to be solved is the development of standard practical tests for measuring dust and gas from furnaces.

A "smog chamber" will be used, into which controlled amounts of sulphur dioxide, water vapor, and various pollutants having a catalytic action can be injected. Preliminary work already has been done on this project. Results will promote a better understanding of the effect, if any, of smog on various aspects of health. Immediate research is being done in appraising smog incidence by locality.

Electrostatic precipitators for dust particles are now used in a number of plants. This equipment polarizes the dust in a stream of air and attracts the particles to metal plates with an opposite charge. Coke-oven doors have been altered to reduce smoke leakage. Much of the smoke discharge from coke ovens normally comes when the coal is put in. A "smoke sleeve" has been designed to funnel this waste to a nearby oven where carbon is dissipated and gases are carried off.

Aluminum Building

A PREFABRICATED building, designed to withstand Arctic winds of 100 mph and temperatures of minus 65 F, has been completed by the Engineer Research and Development Laboratories, Fort Belvoir, Va.

The building, developed under contract with Chrysler Corporation, is of stressed-skin aluminum construction. Side, roof, and floor panels have a honeycomb core, faced both sides with aluminum alloy.

The unit now undergoing tests is 48 ft long, 20 ft wide, and 8 ft high. The length may be varied in 8-ft increments from a basic 8-ft length.

To be used primarily for troop occupancy, the unit contains its own heating and sanitation facilities. The heating system, oil-fired and blast-driven, maintains an indoor temperature of 70 F, when the outdoor temperature is minus 65 F.

A simple, wedge-type connector pin holds the panels together, and the whole unit, from U-channel aluminum floor beams to paneled roof, may be quickly erected by relatively untrained troops. Component parts weights are restricted to approximately 100-lb maximums, and part sizes are such that each may be handled during erection by one or two men wearing arctic mittens.

The structure is the latest in a series being developed by the Engineer Laboratories that will result in a complete family of buildings for all Engineer purposes in very cold climates.

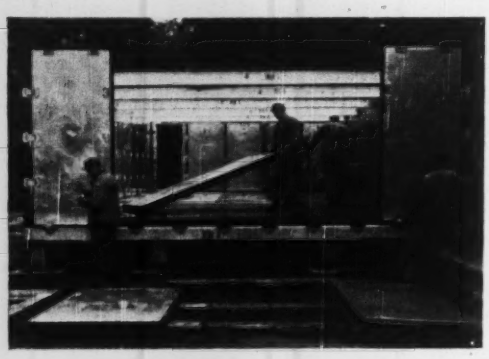


FIG. 5 PREFABRICATED ALUMINUM ARMY TROOP BUILDING IN PROCESS OF CONSTRUCTION SHOWING SIDES AND ONE END COMPLETE, AND CEILING JOISTS IN PLACE

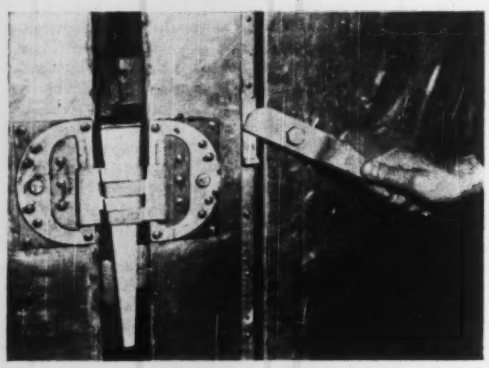


FIG. 6 DETAIL OF CONNECTOR PIN AND LATCH ON ESCAPE DOOR

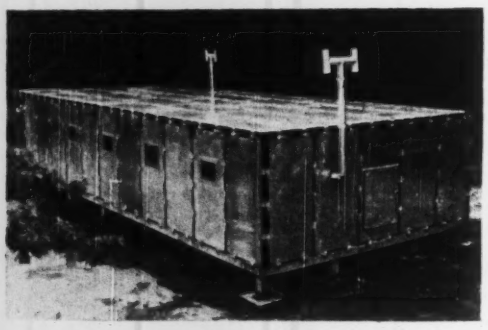


FIG. 7 COMPLETELY ERECTED PREFABRICATED ALUMINUM BUILDING

Coal-to-Oil Plant

COMPLETION of the major construction contract on the Bureau of Mines gas-synthesis demonstration plant at Louisiana, Mo., an 80 to 100-barrel a day unit that will convert coal to oil by a modified Fischer-Tropsch process, was announced by the Department of the Interior (See MECHANICAL ENGINEERING, vol. 71, 1949, pages 499–501).

First of its type in this country, the plant was built under the Bureau's synthetic liquid-fuels research and development program to translate laboratory data into cost and engineering information directly useful to industry in planning, building, and operating commercial-scale installations (5000 or more bbl per day). Koppers Company, Inc. of Pittsburgh, Pa., held the $4,915,000 design and construction contract, now completed.

Much remains to be done, however, before the plant begins integrated operations early next year. Some work remains on the piping insulation and road subcontracts. Large quantities of synthesis catalyst must be prepared and reduced on the site before initial operation. In addition, tests and partial runs will have to be made to prove the operability of the various units and the ability and skill of the operating staff.

This demonstration plant will gasify pulverized coal with oxygen and superheated steam and then convert the resulting synthesis gas—a mixture of carbon monoxide and hydrogen—to liquid fuels by passing it over a catalyst. With American modifications, the Fischer-Tropsch process is well-adapted to the production of a good-grade motor gasoline and an excellent Diesel fuel. Available by-products include alcohols, wax, aliphatic acids, and hydrocarbon gases. Any rank of coal from anthracite to lignite may be used. In Germany, the use of this process increased gradually until January, 1944, when the capacity of the Fischer-Tropsch plants reached a wartime peak of 10,000 bbl of product daily.

Steel Production

FOR every ton of steel made in Russia and the countries she dominates, it is estimated that nearly three tons were poured in the United States in the first half of 1950, and nearly five tons were poured in all other non-communist countries, according to *Steel Facts*, August, 1950.

Steel companies in the United States made more steel than has ever been produced in a six-month period—47,106,000 tons in the first half of 1950. The output of all non-communist countries including the United States was about 80,000,000 tons, up about 6 per cent in the first half of 1950 compared with the first half of 1949, according to data compiled by the United Nations.

Against that 80,000,000 tons, communist countries are estimated to have made 16,500,000 tons in the half year, assuming a 10 per cent increase over the estimated output of the year 1949. The communist countries made only about 21 per cent as much steel as the non-communist nations.

Even if Russian and other communist-dominated countries made 35,000,000 tons of steel in the full year 1950, which is an increase of 19 per cent over their estimated 1949 output, that tonnage would still be one quarter less than the record produc-

tion of the United States in six months. The furnaces in the United States could match this figure, 35,000,000 tons, in a little more than 18 weeks.

Self-Centering Roll

AN application of a hitherto unused natural force is the basis of a new self-centering roll that promises to revolutionize conveying methods for an almost unlimited list of materials. The principle of "planar action" was built into working models by E. T. Lorig, chief of the senior engineering staff of Carnegie-Illinois Steel Corporation, and is now being used in various steel-handling applications in the company's operations.

Fundamentally, the self-centering roll is a slightly crowned roll cut transversely at the center. The two halves are fixed to rotate as a unit. The working surfaces of the two parts are approximately horizontal, while the axes are at an angle. In this way the planes, or lines of force in both halves twist evenly toward the center in the direction of movement, conferring a self-centering action on any materials passing over the rolls. Side guides are consequently unnecessary to keep materials on the conveyer.

Through experimentation it was found that a crown deviation of as little as 0.001 in. from the horizontal is sufficient in a split roll to create the planar action which is the major force of the self-centering roll.

After proving its practicality, Mr. Lorig's chief concern was to find the maximum number of applications for his invention. Each idea that appeared to have merit was developed and as the number of models grew, new applications suggested themselves. The types and shapes of the self-centering rolls were varied and tested at low and high speeds until today an amazing array of model equipment has been built and proved successful.

The rolls have been tested for such a diversity of applications as runout tables, feed and guide rolls for electrolytic tinning, galvanizing and pickling lines, gravity conveyers, belt pulleys and conveyers, and similar applications in the steel industry.

As an example, one of the models is operated by an overhung drive and an overhung take-off, with a smoothly polished, flat stainless-steel belt transmitting the power. The belt remains at dead center on the Lorig rolls, despite the fact that it is driving a variable load at high speed.

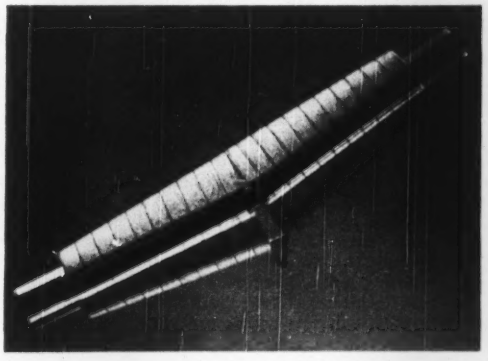


FIG. 8 LINES OF FORCE "TOE IN" TO THE CENTER OF THE LORIG ROLL, AS SHOWN BY THIS LUCITE MODEL

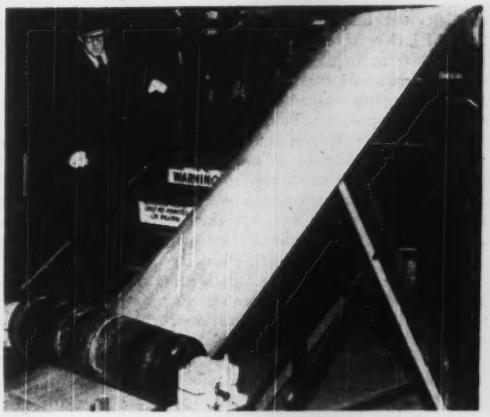


FIG. 9 USE OF SELF-CENTERING ROLL ELIMINATES NEED FOR SIDE GUIDES ON THIS PICKLING-LINE INSTALLATION

One of the more unusual variations in design is a laminated rubber roll with each of the laminations coned on the same principle as the split-crown roll. A stainless-steel belt operating between two of these laminated rolls exhibits the same strong centering action inherent in the original design. In fact, the planar action of any of the Lorig rolls exerts a greater force than gravity. The pulley assembly can be mounted vertically and the metal belt pulled down against the lower pulley housings, yet the belt will rise back to center itself on the split pulleys as the assembly is rotated.

Conical rolls split across the center and nested to form a circular conveyer table exhibit such a strong centering action that objects of any size or shape (other than spherical) being rotated on the table will not deviate from their lines of travel even when the table is tilted from the horizontal.

In its practical applications in the steel industry, the self-centering roll will eliminate the need for table guides and side rails on runout tables and in many other conveyer applications. Hence edge and corner damage to sheets, strip, and plates can be eliminated.

It is pointed out that width of conveyer tables and run-out tables can be reduced to a bare minimum with no edge or corner damage to the material being conveyed or risk to the operator. Gravity conveyers, whether straight or curved, can be built to operate efficiently with no guide rails. Belt drives are practical and safe, even with an overhung take-off. Operating on self-centering rolls, stainless-steel conveyer belts are now practical and safe under low operating tensions.

Silicone Rubbers

A RECENT investigation at the National Bureau of Standards under the joint sponsorship of the Office of Naval Research and the Quartermaster Corps has shown that the silicone rubbers, developed especially for high-temperature applications, have better potentialities for use at extremely low temperatures than any synthetic or natural rubber studied thus far.

The silicones are synthetic rubbers in which some of the carbon atoms normally present are replaced by silicon and oxygen. Since these materials are highly resistant to heat, retaining their

elasticity and electrical resistance at temperatures as high as 200 C (392 F), they have been found especially well suited for hose and gaskets in airplane engines and for insulated cables. In recent years a need has also arisen for a type of rubber capable of withstanding low temperatures without loss of its characteristic rubberlike properties. Tires, belting, or other articles of ordinary rubber lose their elasticity around —50 C (—60 F), presenting many difficulties in connection with the operation of motor vehicles and machinery in the arctic or of airplanes at great height. To learn more about the possibilities of using the silicones for such low-temperature applications the Bureau determined the lower limit of the temperature range in which they retain their characteristic elasticity.

This was accomplished by locating the second-order transition temperature, a temperature at which a marked change in the slope of the length-temperature curve occurs. Such a change is observed in all rubbers and plastics and can be recognized as a discontinuity in the derivatives of volume, heat content, index of refraction, compressibility, dielectric constant, and other quantities with respect to temperature. A second-order transition differs from the ordinary first-order transition, or change of phase, in that no volume change or latent heat is involved. However, below the second-order transition temperature the type of molecular motion responsible for the useful properties of a rubber ceases, and the material behaves essentially as an ordinary solid. In practice a rubber becomes useless for applications requiring long-range elasticity at temperatures somewhat higher than the transition temperature, the exact amount of the difference depending on the particular application. Thus in natural rubber the second-order transition temperature is at —70 C (—94 F), but the rubber is seldom useful below about —55 C (—67 F).

In the Bureau's investigation, the necessary thermal-expansion measurements were made in an interferometer. Small slabs of rubber were placed between the two quartz interferometer plates. Then, as the temperature of the interferometer was changed, the rubber slabs contracted or expanded, changing the distance between the plates and causing the interference fringes to the eyepiece to move relative to a fixed point of reference. The temperature of the specimens was recorded, and the number of fringes passing the reference point were counted as the temperature was varied slowly from —196 C (—321 F), the boiling point of liquid nitrogen, to 100 C (212 F).

The silicone rubbers studied were all of commercial origin, and all except two, which were pure-gum silicones, contained fillers and vulcanizing agents. Several of the samples were especially designed for low-temperature applications. As only small differences in transition temperature were observed among any of these samples, it was concluded that fillers and vulcanizing agents have little effect on the second-order transition temperature. Additional measurements on two commercial silicone rubbers not designed for low temperatures were in substantial agreement with those for the low-temperature silicones.

One variety of low-temperature silicone rubber was outstanding in that its expansion curve was essentially linear from 100 C (212 F) until the second-order transition temperature of approximately —123 C (—189 F) was reached. Below this temperature a much lower coefficient of thermal expansion, more nearly like that of a rigid solid, was observed. All other silicone rubbers studied likewise exhibited a second-order transition at approximately —123 C, the lowest temperature at which such a transition has been observed in a polymeric material. However, the other silicones, on being cooled from room temperature, also went through a first-order transition at temperatures varying from —65 C (—85 F) to —75 C (—103 F).

The first-order transition was observed experimentally as the very rapid passage of a large number of fringes past the reference point while the temperature was varied over a narrow range.

This effect was interpreted as corresponding to a considerable decrease in volume associated with partial crystallization of the amorphous silicone. The crystallization process produces some stiffening and has apparently prevented the successful use of silicone rubbers below this temperature. However, the one variety which exhibited no first-order transition should have good possibilities for use at temperatures as low as —100 C (—148 F).

On heating the partially crystalline material, melting was found to occur over a range of temperatures considerably higher than those required to produce crystallization. This behavior is analogous to that shown by natural rubber. The volume change of the pure-gum silicone rubber on crystallization or melting varied over a range from 2.0 to 7.8 per cent. Between 0 C and —35 C, the expansivity of the pure material was about 40×10^{-5} per deg C. Similar data were obtained for the silicones containing fillers and vulcanizing agents, but the values obtained were lower because of the presence of these ingredients.

Color-Film Processing

A NEW high-speed technique which cuts the time required for processing of color from 90 to 20 min, and the printing time from 90 to 15 min, will soon be making color pictures as readily available as black and white, it was revealed in the the Cado *Technical Data Digest*, August, 1, 1950. The kit of chemicals, developed by the Ansco Division of the General Aniline and Film Corporation of Binghamton, N. Y., has just been put through a series of rigid exhaustion and fading tests by the Engineering Division's Photographic Laboratory at Air Materiel Command Headquarters. So far the color quality resulting from the new process has shown itself to be normal to, or better than that achieved in normal processing methods, the article states.

Photographic Laboratory engineers point out that the new process will eliminate the lag which now exists between the time pictures are taken by reconnaissance crews and the time they are ready for use by strategical or tactical units.

Basis of the new method is a prehardener which permits the processing to be done at 80 F instead of the 68 to 70 F used in the normal process. The hardener prevents the emulsion from becoming too soft at this higher temperature. Extensive research has also resulted in the alteration of the chemicals in the present kit so that they meet the higher heat requirements, and so that they can be used for either film or paper with the addition of only one special ingredient.

At present the supply of new kits is limited and the complete output will be turned over to the Armed Services. The material will not be available to commercial users until military requirements have been met. Present kits are being made up only in the $3^1/_2$-gal size. Service tests will be conducted at Eglin and Lowry Air Force Bases, and if subsequent tests prove as satisfactory as those which have already been completed, the new method of processing will be standardized.

It is expected that all field units will have the new kits within a year, and it will then be possible to make extensive use of color film for photo reconnaissance work. Because color photographs are much better than black and white for camouflage detection and general interpretation, the new rapid process is expected to be of immeasurable value.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Oil and Gas Power

Design Features of the Nordberg Radial Engine, by Donald I. Bohn, Aluminum Company of America, Pittsburgh, Pa., and Emil Grieshaber, Mem. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1950 ASME Oil and Gas Power Division Conference paper No. 50—OGP-1 (mimeographed; to be published in Trans. ASME).

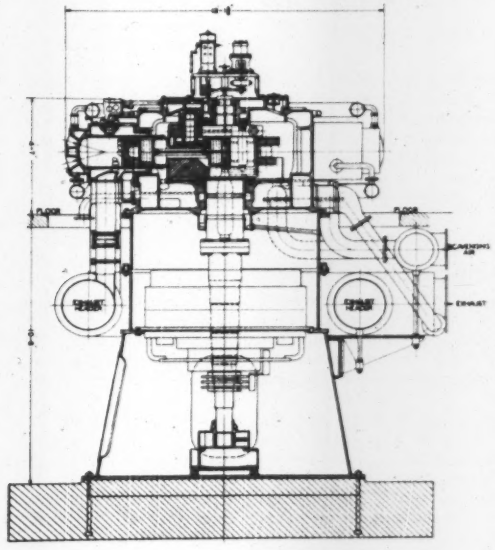
THE Nordberg radial engine has 11 cylinders of 14 in. bore and 16 in. stroke and at 400 rpm develops 1800 hp or 1250 kw. It is of the two-cycle type with port scavenging and port exhaust, the piston undercovering the ports in the cylinder walls thereby eliminating intake and exhaust valves. It can operate as a spark-fired gas engine, as a Diesel engine, or as a dual-fuel engine.

The motor-driven scavenging blower, lube oil, and water pumps can be connected directly to the leads of the generator, thus making a self-contained automatic unit, with a net capacity of 1150 kw; or power may be supplied to the auxiliaries from a station bus-bar, and utilizing the gross output of the engine for pump or compressor drives.

The basic advantages of a radial engine are as follows: It is simple, compact, sturdy, and light in weight, needs minimum foundations, and small floor space. This engine with its welded base is about 12 ft wide, 9 ft 4 in. high, weighs approximately 85,000 lb, and can be shipped by rail as an assembled unit.

Since the cylinders fire one after the other in clockwise rotation the piston loads are transmitted to the crankpin at an even sequence, consequently the torque variations are small in magnitude. Opposite pistons counteract the peak cylinder pressures and therefore the resulting loads on the crankpin and the two main bearings are greatly reduced and of small variation. This effect, together with a small number of bearings, reduces friction and improves the mechanical efficiency of the engine.

The radial arrangement of the cylinders makes possible a perfect static and dynamic balance of the engine.



CROSS SECTION OF RADIAL ENGINE

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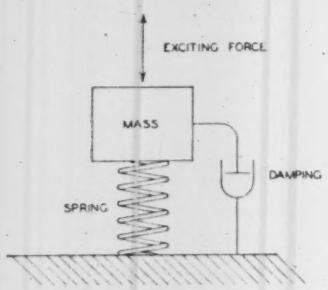
Principles of Foundation Design for Engines and Compressors, by Wallace K. Newcomb, Mem. ASME, Ingersoll-Rand Company, Painted Post, N. Y. 1950 ASME Oil and Gas Power Division Conference paper No. **50—OGP-5** (mimeographed; to be published in Trans. ASME).

FOUNDATIONS for reciprocating machines differ from foundations for buildings or similar structures since dynamic rather than static loads are involved. With a static load, only the bearing capacity of the soil need be considered and there are various well-known rules to follow. With a dynamic load, however, these rules do not apply, since the frequency of the forces and danger of resonance with attendant excessive vibration must govern foundation design.



FOUNDATION REPRESENTED AS A SPRING-SUPPORTED MASS

This paper discusses the elastic character of the ground and shows that foundations for reciprocating machines can be treated as spring-supported masses, the machine and foundation representing the mass and the ground the spring. Such elastic systems have natural periods of vibrations and if the frequency of unbalanced inertia or other exciting forces is near the natural frequency of the foundation, resonance occurs producing excessive vibration. Examples of this phenomena are given and tests on foundations having resonance are described. Also, the nature of inertia forces found in reciprocating machines is explained. Examples of good and bad foundation design are shown and a rational method for foundation design is outlined.

Starting Requirements of Diesel Engines on Locomotives, by F. H. Brehob, Mem. ASME, General Electric Company, Erie, Pa. 1950 ASME Oil and Gas Power Division Conference paper No. **50—OGP-3** (mimeographed).

ELECTRIC starting, using power from a storage battery, is now practically the universal method used for cranking the Diesel engines on locomotives. In most cases the main generator is arranged to serve as a starting motor, although some small engines used in locomotive work are equipped with automotive-type starters.

While the battery serves for other purposes as well as for starting, its size is fixed principally by the engine-cranking requirements and, in some cases, by characteristics of the starting motor.

As the size of the engine increases, the battery capacity required also increases.

The locomotive builder has taken the initiative and has made tests to attempt to actually determine the starting requirements when the engine is cranked electrically. This information is necessary to insure using the correct-size battery and building the correct characteristics into the machine that serves as a starting motor.

The locomotive designer needs to know three fundamental things regarding engine starting: (1) maximum torque during first revolution, (2) torque at firing speed, and (3) firing speed.

The paper gives data and starting tests, empirical formulas for designers, and actual applications of the formulas.

The Berry Hydraulic Transmisssion, by A. G. Holmes, Jr., Mem. ASME, Mississippi State College, State College, Miss., and O. D. M. Varnado, Mem. ASME, Berry Motors Inc., Corinth, Miss. 1950 ASME Oil and Gas Power Division Conference paper No. **50—OGP-2** (mimeographed).

THE results of a test on a combination of hydraulic pump and motor forming a hydraulic power-transmission system of high efficiency and a discussion of the unique mechanical details of the Berry pump and motor which make this high efficiency possible are given in this paper.

In the test, the hydraulic pump is driven by a constant-speed electric motor and the hydraulic motor drives a dynamometer. Since the motor is expected to operate at variable speeds, there is a three-way valve to by-pass the excess oil from the pump. The oil leaving the motor is measured to obtain the volume used per unit time. An intercooler is installed in the suction line to the pump to maintain as nearly as possible a constant oil temperature.

The pump was rated 13 gpm at 1000 rpm and the motor 10.87 gpm at 2000 rpm. The hydraulic medium used during the test was Ucon LB-400-X.

Tests so far on Berry hydraulic motors show that the torque remains constant at constant pressure regardless of speed up to the highest speeds at which tests have been made, and also that torque varies directly as the imposed pressure on the motor unit. This indicates that over a large range of speed, flow is laminar.

The authors believe that the results as presented show that this transmission system can attain efficiencies comparable to other transmission systems now in general use, and that the system with its relatively high efficiency, its simplicity, and its flexibility offers definite advantages in numerous fields of application involving the transmission of power at variable speeds.

Analysis of the Exhaust Process in Four-Stroke Reciprocating Engines, by John D. Stanitz, Mem. ASME, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1950 ASME Oil and Gas Power Division Conference paper No. **50—OGP-4** (mimeographed; to be published in Trans. ASME).

THIS analysis determines the influence of engine design and operating variables upon the effectiveness of the exhaust process. This effectiveness is measured by the calculated pressure ratio (cylinder pressure divided by exhaust manifold pressure) near the end of the exhaust stroke. The variables that have an important effect upon this pressure ratio are the gas-velocity parameter (which is a ratio including the engine speed, piston displacement, exhaust-valve area, exhaust-valve flow coefficient at maximum valve lift, etc.) and the effective exhaust valve closing angle. The variables that have an unimportant effect are the pressure ratio at the effective exhaust-valve opening angle (which, however, does become important for highly supercharged engines), the effective exhaust-valve opening angle, the engine compression ratio, the ratio of crank throw to connecting-rod length, and the ratio of specific heats.

The maximum value recommended for the gas-velocity parameter is 0.325. From this value the minimum exhaust-valve area can be directly calculated for any given engine speed, displacement volume, etc.

For large values of the gas-velocity parameter the exhaust valve should be closed as late as possible. For most current engine operating conditions the correct exhaust-valve area does not depend upon the intake-valve area or upon the ratio of intake-to-exhaust-manifold pressure (except for highly supercharged engines).

Fluid Flow, Heat, Valve Theory

Momentum and Mass Transfer in Coaxial Gas Jets, by Walton Forstall, Jr., Jun. ASME, Carnegie Institute of Technology, Pittsburgh, Pa., and Ascher H. Shapiro, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1950 ASME Applied Mechanics Conference paper No. **50—APM-13** (in type; to be published in the *Journal of Applied Mechanics*).

THE mixing at constant pressure of a circular jet with an annular coaxial stream has been studied for conditions of nearly common density and temperature, but differing initial velocities. By using 10 per cent by volume of helium as a tracer in the inner stream, the mixing region was mapped with respect to both material and momentum transfer. It is concluded that material diffuses more rapidly than momentum; that the principal independent variable determining the shape of the mixing region is the velocity ratio of the streams; and that the integral method of Squire and Trouncer, using experimentally determined constants, is adequate for predicting approximate values of concentration and velocity in the mixing region of a jet flowing into a moving medium of the same density. Data for widely different experiments of various investigators show that the turbulent Prandtl and the Schmidt numbers are both within ±10 per cent of 0.70, independent of the nature of the experiment and the magnitudes of the laminar Prandtl and Schmidt numbers.

Characteristics of Irrotational Flow Through Axially Symmetric Orifices, by Hunter Rouse, Mem. ASME, State University of Iowa, Iowa City, Iowa, and Abdel-Hadi Abul-Fetouh, Farouk El-Awal University, Alexandria, Egypt. 1950 ASME Applied Mechanics Conference paper No. **50—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

ALTHOUGH an exact analytical solution of the orifice problem has not yet proved feasible, use of the method of relaxation has permitted a numerical determination of the flow characteristics to be made with sufficient precision for the problem to be considered solved. The coefficient of contraction is found to be practically identical with that evaluated by von Mises for two-dimensional flow from slots over the entire range of area ratio, and reasonable agreement is shown to exist between measurement and computation. Co-ordinates of the jet profiles are presented in tabular and graphical form, and are found to differ appreciably from those previously adapted from the two-dimensional case. A composite dimensionless chart is also provided showing the distribution of pressure along the boundary and center line and across the efflux section for the various area ratios.

Temperature Distribution in a Steady, Laminar, Preheated Air Jet, by Chia-Shun Yih, University of British Columbia, Vancouver, B. C., Canada. 1950 ASME Applied Mechanics Conference paper No. **50—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper contains an exact closed solution for the temperature distribution in a preheated air jet when the flow is steady and laminar. Both the two-dimensional and the axially symmetric cases have been treated. The solution is immediately applicable to other similar problems of diffusion.

The Theory of Spring-Loaded Valves for Reciprocating Compressors, by Michael Costagliola, Jun. ASME, Sperry Gyroscope Company, Great Neck, N. Y. 1950 ASME Applied Mechanics Division Conference paper No. **50—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

THE inlet and discharge processes of a reciprocating compressor equipped with spring-loaded valves of the automatic type have been analyzed to determine the effects of the main design variables on performance. The most important criterion is found to be a parameter involving effective flow area through the valves and piston speed. Valve dynamics are a secondary consideration. For optimum valve dynamics, the valve would have no weight and a very small spring constant, giving an infinite natural frequency of the valve system. If certain valve characteristics are known (or measured by static-flow test), the performance of a compressor using these valves can be predicted with fair accuracy.

Graphical, Mechanical, and Electrical Aids for Compressible Fluid Flow, by H. Poritsky, Mem. ASME, C. E. Danforth, General Electric Company, Schenectady, N. Y., and B. E. Sells, General Electric Company, Lynn, Mass. 1949 Applied Mechanics Conference paper No. **49—APM-24** (in type; published in the *Journal of Applied Mechanics*, March, 1950, pages 37–46).

GRAPHICAL, mechanical, and electrical methods of studying two-dimensional and axially symmetrical irrotational flow of nonviscous compressible fluids are described and examples are given of problems solved by these methods. Rules for the construction of compressible flux plots using wires, beads, and a suitable device for obtaining the desired length-width ratios of the rectangles are derived, and the apparatus used is described. An analogy is described by means of which these problems can be solved by the use of a d-c resistance board, employing variable resistances which are adjusted to conform to the derived relations. Designers and aerodynamicists in need of solution for problems for which no analytical solutions are available can use the methods described in this paper to obtain the required solutions.

Plastic Flow

The Use of Skewed Rolls in Calendering Operations, by G. F. Carrier, Jun. ASME, Brown University, Providence, R. I. 1950 ASME Applied Mechanics Conference paper No. **50—APM-10** (in type; to be published in the *Journal of Applied Mechanics*).

IN many commercial operations it is desirable to produce a uniform sheet of material by passing the viscous raw ingredients through rotating cylindrical rolls. With rolls supported at the ends only there is danger of wide variations in thickness of the finished product. This may be overcome by "skewing" the rolls the amount necessary for any given thickness and material properties. This paper presents an analytical approach to determining the optimum operating position of the rolls.

Solution to the Rolling Problem for a Strain-Hardening Material by the Method of Discontinuities, by Alice Winzer, Brown University, Providence, R. I. 1950 ASME Applied Mechanics Conference paper No. **50—APM-19** (in type; to be published in the *Journal of Applied Mechanics*).

THE problem of drawing and rolling of a thin plastic sheet between cylindrical guides was investigated recently by H. I. Ansoff, under the assumption that the material is in a state of plane plastic flow and obeys the Saint Venant-Mises yield condition. He determined the stress distribution along the sheet by the method of characteristics and also by the method of discontinuity surfaces and found good agreement between these results as well as with experimental data. Since the computations required

for the discontinuous solution are considerably less laborious than those necessary for the continuous solution, the same type of problem, but now under the assumption that the material displays strain-hardening, will be analyzed by the method of discontinuities. It seems reasonable to expect that the results so found constitute a close approximation to results based upon a continuous solution.

Plastic Biaxial Stress-Strain Relations for Alcoa 24S-T Subjected to Variable-Stress Ratios, by Joseph Marin, Mem. ASME, and B. J. Kotalik, Pennsylvania State College, State College, Pa. 1950 ASME Applied Mechanics Conference paper No. **50—APM-16** (in type; to be published in the *Journal of Applied Mechanics*).

USUALLY plastic biaxial stress-strain relations for metals have been determined for tests in which the ratios of the principal stresses have been maintained essentially constant. This paper presents biaxial plastic stress-strain relations for both constant and variable-stress ratios. The purpose for conducting the variable-stress-ratio tests is to attempt to prove whether the flow or deformation-type theory is the correct theory for predicting plastic stress-strain relations. The paper also gives a comparison between the actual and theoretically predicted values of the biaxial yield, ultimate and fracture strengths, and the biaxial ductility. Various ratios of biaxial tensile stresses were investigated by subjecting tubular specimens to axial tension and internal pressure. The test results showed that the yield-strength values agree best with the distortion-energy theory. For the prediction of the plastic stress-strain relations the deformation-type theory was found to be in approximate agreement with the test results for both the constant and variable-stress-ratio tests.

A Method of Numerical Analysis of Plastic Flow in Plane Strain and Its Application to the Compression of a Ductile Material Between Rough Plates, by R. Hill, British Iron and Steel Research Association, Doncaster, Sheffield, England, E. H. Lee, Mem. ASME, Brown University, Providence, R. I., and S. J. Tupper, Ministry of Supply, London, England. 1950 ASME Applied Mechanics Conference paper No. **50—APM-17** (in type; to be published in the *Journal of Applied Mechanics*).

PROBLEMS of plastic flow which arise in practice, with complicated boundary conditions, are seldom amenable to exact analysis, and it becomes necessary to devise some numerical method of solution. This paper describes a rapid numerical procedure for the determination of the stress and velocity distributions in plane plastic flow where the plastic strains are large. The method is applied to the problem of the squeezing of a plastic material between rough plates. This example has been chosen as it illustrates the treatment of most types of boundary conditions likely to be encountered and supplies for contrast several incomplete solutions attempted by previous authors. The solution shows the fallacy of the apparent static determinancy of the plane plastic problem, indicating the need to consider the velocity field in obtaining the true distribution of stress. A further advantage of this example is the possibility of checking the numerical procedure, which is found to be extremely accurate.

Beam and Plate Vibrations

Natural Frequencies of Continuous Beams of Uniform Span Length, by R. S. Ayre and L. S. Jacobsen, Mem. ASME, Stanford University, Stanford, Calif. 1950 ASME Applied Mechanics Conference paper No. **50—APM-21** (in type; to be published in the *Journal of Applied Mechanics*).

A SIMPLE graphical network is used to determine the natural frequencies of flexural vibration of continuous beams having any number of spans of uniform length. The network is based upon a relatively few calculated values.

Transverse Vibration of a Two-Span Beam Under the Action of a Moving Alternating Force, by R. S. Ayre and L. S. Jacobsen, Mem. ASME, Stanford University, Stanford, Calif. 1950 ASME Applied Mechanics Conference paper No. **50—APM-2** (in type; to be published in the *Journal of Applied Mechanics*).

AN alternating force (for example, due to unbalance in a locomotive driving apparatus) moves across a symmetrical two-span beam (or equivalent bridge) with uniform velocity. The stress-time equations for the three time-eras of the problem have been derived by classical methods. The experimental part of the investigation employs a mechanical system with wire-resistance strain gages. Resonances from the first through the sixth mode have been investigated. There is good agreement between theory and experiment in so far as number and location of resonances are concerned. The discrepancy in amplitude is to be expected due to the omission of damping in the theory. The most important observation is the "multiplicity of resonances" associated with "each" natural mode.

Vibration of Rectangular Plates by the Ritz Method, by Dana Young, Mem. ASME, University of Texas, Austin, Texas. 1950 ASME Applied Mechanics Conference paper No. **50—APM-18** (in type; to be published in the *Journal of Applied Mechanics*).

RITZ'S method is one of several possible procedures for obtaining approximate solutions for the frequencies and modes of vibration of thin elastic plates.

The accuracy of the results and the practicability of the computations depend to a great extent upon the set of functions that is chosen to represent the plate deflection. In this investigation, use is made of the functions which define the normal modes of vibration of a uniform beam. Tables of values of these functions have been computed as well as values of different integrals of the functions and their derivatives. With the aid of these data, the necessary equations can be set up and solved with reasonable effect

Solutions are obtained for three specific plate problems, namely. (*a*) square plate clamped at all four edges, (*b*) square plate clamped along two adjacent edges and free along the other two edges, and (*c*) square plate clamped along one edge and free along the other three edges.

Influence of Rotatory Inertia and Shear on Flexural Motions of Isotropic, Elastic Plates, by R. D. Mindlin, Mem. ASME, Columbia University, New York, N. Y., and Consultant, Bell Telephone Laboratories, Murray Hill, N. J. 1950 ASME Applied Mechanics Conference paper No. **50—APM-22** (in type; to be published in the *Journal of Applied Mechanics*).

A TWO-DIMENSIONAL theory of flexural motions of isotropic, elastic plates is deduced from the three-dimensional equations of elasticity. The theory includes the effects of rotatory inertia and shear in the same manner as Timoshenko's one-dimensional theory of bars. Velocities of straight-crested waves are computed and found to agree with those obtained from the three-dimensional theory. A uniqueness theorem reveals that three edge conditions are required.

Vibrations, Impact, Buckling

Vibrations of Elastic Systems Having Hereditary Characteristics, by Enrico Volterra, Illinois Institute of Technology, Chicago, Ill. 1950 ASME Applied Mechanics Conference paper No. **50—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

RESULTS of experiments carried out on plastics and rubberlike materials at high rate of straining are given. It is shown that the dynamic stress-strain (σ, ϵ) relationship for those materials can be expressed by the formula

$$\sigma = f(\epsilon) + \int_0^t \phi(t-\tau)\frac{d\epsilon(\tau)}{d\tau}\,d\tau$$

The first term represents the static stress-strain relationship, while the second depends on the rate of straining $\frac{d\epsilon}{dt}$. As a first approximation it is supposed that the materials follow Hooke's law when statically stressed. Equation [1] then becomes

$$\sigma = E\epsilon + \int_0^t \phi(t-\tau)\frac{d\epsilon(\tau)}{d\tau}\,d\tau$$

Materials which follow the second equation are called materials with "hereditary characteristics." Vibrations of single-degree-of-freedom systems having hereditary characteristics are considered. Methods of finding the hereditary function $\phi(t)$ from forced vibrations are given. Free and forced vibrations of simply supported beams having hereditary characteristics are studied.

The Dynamics of the Buckling of Elastic Columns, by N. J. Hoff, Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1950 ASME Applied Mechanics Conference paper No. **50—APM-23** (in type; to be published in the *Journal of Applied Mechanics*).

THE motion of a perfectly elastic initially slightly curved column is calculated when one of its ends is displaced axially at a constant speed in a perfectly rigid testing machine. A nondimensional quantity Ω is defined which depends only upon the slenderness ratio of the column and the ratio of the velocity of the propagation of sound in its material to the speed of the testing machine. Two elastic columns are dynamically similar if Ω and the initial deviations from straightness are the same for both of them. The dynamic transverse deflections of the column lag behind the static values at the outset and overshoot them later. At an advanced stage of the loading the dynamic deflections can be represented as oscillations superimposed upon the static deflections. The axial compressive force in the column increases proportionately to the displacement of the loading head of the testing machine in the first phase of the loading. When the deflections become large, the compressive force increases at a reduced rate, reaches a maximum, and finally begins to oscillate about the Euler load. The maximum force recorded on the testing machine can be a multiple of the Euler load when Ω is large and the initial deviations from straightness are small. At ordinary speeds and with the usual inaccuracies of routine testing the maximum load should differ little from the Euler load.

An Iterative Numerical Method for Nonlinear Vibrations, by J. E. Brock, Jun. ASME, Washington University, St. Louis, Mo. 1950 ASME Applied Mechanics Conference paper No. **50—APM-1** (in type; to be published in the *Journal of Applied Mechanics*).

A SIMPLE iterative procedure employing numerical integrations is presented for the analysis of free and forced vibrations of undamped systems having nonlinear elasticity. If the elasticity is symmetrical, it is always possible to make an excellent initial approximation, but the method may also be used in cases of unsymmetrical elasticity. Other applications, such as to systems having parameters which vary with time, are discussed.

Impact on a Multispan Beam, by W. H. Hoppmann, 2nd, Mem. ASME, The Johns Hopkins University, Baltimore, Md. 1950 ASME Applied Mechanics Conference paper No. **50—APM-15** (in type; to be published in the *Journal of Applied Mechanics*).

IN this paper a study is made of impact on a continuous beam on four supports. The impact is produced by collision of a solid sphere with the beam at the midpoint of the center span. The spans are of equal length and of constant cross section. Formulas are obtained for the deflections and strains. A numerical example illustrating the theory is worked out in detail.

Elasticity, Shell Theory

On the General Theory of Thin Shells, by W. R. Osgood, Mem. ASME, David Taylor Model Basin, Washington, D. C., and J. A. Joseph, Headquarters, United States Air Force, Washington, D. C. 1950 ASME Applied Mechanics Conference paper No. **50—APM-14** (in type; to be published in the *Journal of Applied Mechanics*).

IN the general theory of shells expressions are obtained for the changes of curvature and the twist, and revisions are introduced in the equations of equilibrium.

Effect of Stress-Free Edges in Plane Shear of a Flat Body, by W. T. Read, Bell Telephone Laboratories, Murray Hill, N. J. 1950 ASME Applied Mechanics Conference paper No. **50—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper determines the tangential stiffness of a flat rectangular body, or shear pad, with a uniform relative tangential displacement on the upper and lower surfaces. The state of stress differs from pure shear in that the edges are stress-free. The correction to the stiffness in pure shear is obtained as a function of Poisson's ratio and the length-to-thickness ratio. The paper also illustrates the power of energy methods in furnishing accurate approximations with a small amount of numerical work when only over-all quantities, such as stiffness, are being investigated. By manipulating energy relations and using the Prager-Synge approximate method a few hours of slide-rule computation was sufficient to determine both upper and lower bounds for the stiffness.

Elastic Torsion in the Presence of Initial Axial Stress, by J. N. Goodier, Mem. ASME, Stanford University, Stanford, Calif. 1950 ASME Applied Mechanics Conference paper No. **50—APM-4** (in type; to be published in the *Journal of Applied Mechanics*).

THE torsional rigidity, for small elastic torsion, of bars of thin-walled open section, is, in general, altered by initial tension, compression, bending, or other axial stress. This appears in the increase of torsional stiffness of strips due to tension, in the decrease to zero in open sections which buckle torsionally as columns, and also has an influence on lateral buckling of beams. This paper contains an extension of the Saint Venant solution for ordinary tor-

sion to the problem of torsion in the presence of initial axial stress with any distribution on the cross section. The results are confirmed by tests, and validate the intuitively derived formulas which are in use.

Stress Concentration

Stress Concentrations Around Spheroidal Inclusions and Cavities, by R. H. Edwards, Illinois Institute of Technology, Chicago, Ill. 1950 ASME Applied Mechanics Conference paper No. **50—APM-20** (in type; to be published in the *Journal of Applied Mechanics*).

PREVIOUS investigations have been concerned with the stress concentration around a spheroidal cavity under certain restricted loading assumptions. In this paper exact closed solutions are obtained for the following: (*a*) The distribution of stress around a spheroidal inclusion in an elastic body which is in an arbitrary uniform state of stress infinitely far from the inclusion, and, in particular, for the distribution of stress around a spheroidal cavity under the same loading conditions. (*b*) The thermal stress distribution arising from distinct uniform temperature changes applied to the spheroidal inclusion and the surrounding medium. Technically important features of the solutions obtained are discussed.

The Stresses Around a Small Opening in a Beam Subjected to Pure Bending, by J. A. Joseph, Headquarters, U. S. Air Force, and J. S. Brock, David Taylor Model Basin, Washington, D. C. 1950 ASME Applied Mechanics Conference paper No. **50—APM-3** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper contains an exact closed solution for the stress distribution around a small opening in the web of a beam that is subjected to pure bending. The complex variable method of solution for plane stress problems (Muschelisvili) is outlined. It is applied to the case of a general ovaloid opening (Greenspan). Curves showing the tangential stresses around the boundary are given for several common openings found in engineering structures.

Torsion of a Circular Shaft With a Number of Longitudinal Notches, by H. Ökubo, Töhoku University, Sendai, Japan. 1950 ASME Applied Mechanics Conference paper No. **50—APM-7** (in type; to be published in the *Journal of Applied Mechanics*).

THE object of this paper is to find a solution for the torsion problem of a circular shaft with a number of longitudinal semicircular notches. By using elementary functions the author has been able to simplify the numerical calculations in contrast to previous work in similar cases by other writers.

Tosional Stress Concentration in Angle and Square Tube Fillets, by J. H. Huth, Stanford University, Stanford, Calif. 1950 ASME Applied Mechanics Conference paper No. **50—APM-9** (in type; to be published in the *Journal of Applied Mechanics*).

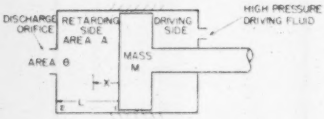
THIS paper points out the wide variation in the results of previous investigations into the stress concentration at the fillets of angle sections subjected to uniform torsion. The relaxation method is applied and new results are given (not in agreement with previous results) for both angle sections and thin-walled square-tube sections. These results are believed to be within 4 per cent of the correct values, and they cover a complete range of fillets of all sizes. Also, the maximum shearing stress and torsional rigidity are given for a prismatical bar whose cross section is formed by a circular quadrant tangent to two sides of a square. It is pointed out that the stress concentration in angle sections with generous fillets may be lowered considerably by rounding off the outside corner in such a way as to keep the thickness of the section everywhere approximately constant.

Industrial Instruments

Compressibility Effect in Hydraulic Servomechanisms, by Robert Senters Wick, University of Illinois, Urbana, Ill. 1950 ASME Industrial Instruments and Regulators Division—Instrument Society of America Conference paper No. **50—IIR-1** (mimeographed).

THIS paper is the first of a series of investigations of compressibility effects in hydraulic servomechanisms, and it makes a preliminary investigation of the effects of the elasticity of the fluid on the response to an input signal of a typical valve-controlled servomechanism.

In the piston and cylinder of a control system of the type being discussed, the valve on the driving side opens when a signal is applied and pressure is assumed to reach some value F/A instantaneously. The piston and the load start to move, and the fluid in the retarding side is forced out of the cylinder through the discharge orifice. Friction in the discharge line is neglected in this analysis. As the piston and load reach the desired position as indicated by the input signal, the outlet orifice will be closed along with the inlet valve. During this stage of the response, the analysis becomes considerably more complicated. The present discussion is limited to the initial stage of the response when the area of the discharge orifice remains essentially constant.



TYPICAL CYLINDER AND PISTON OF HYDRAULIC SERVO

Equations of motion are derived for the case when the fluid is considered as incompressible. The effect of considering the changes in density of the fluid with changes in pressure are also discussed. It is shown that this last factor is of little or no importance in the practical case. The final analysis consists of taking into account the fact that a finite length of time is required for pressure changes to be transmitted in any system. In other words, the effects of the pressure waves generated by the movement of the piston are considered. In the case of an incompressible fluid, all pressure changes are assumed to be transmitted with infinite speed.

A Direct-Recording Technique for Pressure Cycles in High-Pressure Reciprocating Equipment, by R. A. Strub, E. I. du Pont de Nemours & Company, Inc., Charleston, W. Va. 1950 ASME Industrial Instruments and Regulators Divison—Instrument Society of America Conference paper No. **50—IIR-2** (mimeographed).

THE necessity of obtaining, by a simple method, information concerning the performance of high-pressure piston compressors or pumps has led to the study of a direct-recording technique making use of the strain in the plunger rod. The principal purpose was to avoid machine modification as well as the use of more conventional devices so that the recording element could be left permanently on the machine for frequent or constant survey even when processing a corrosive fluid.

This technique has been successfully

applied in the measurement of fluctuating high pressure in cylinders of gas compressors and pumps. The direct recording method does not require any modification of the compressor. The axial strain is easily recorded by Baldwin SR-4 strain gages connected through an amplifier to a pen recorder or an oscilloscope, or other recording device, and reflects with sufficient accuracy the fluid compressibility, the functioning of the valves, the influence of variations in the discharge volume, etc. Valuable information regarding output efficiency and indicated power is obtained. This technique is useful as an operating instrument to monitor continuously or intermittently the pressure cycle in one or several compressors, and therefore provides indications of any deviation from the normal operating conditions. Indicator diagrams from tests on a gas compressor are reproduced and discussed.

Blast-Furnace Instrumentation, by E. T. Mortson and S. J. Paisley, National Tube Company, McKeesport, Pa. 1950 ASME Industrial Instruments and Regulators Division-Instrument Society of America Conference paper No. **50—IIR-3** (mimeographed).

INDICATING and recording instruments are used extensively at the blast furnace to give pressure, temperature, or flow information that is necessary to safety or as a guide to proper operation. They are also useful in determining operating efficiency. Instruments used to control variables such as temperature or humidity are timesaving and maintain furnace conditions more uniform than could possibly be accomplished by constant personal attention.

Formerly, a few pressure indicators and a top gas temperature hot-blast temperature indicator were the only "guides" generally employed throughout the industry. Today, it requires a large panel to house the instruments that day after day furnish reliable information such as temperatures, pressures, and flows. Although the degree of reliability of data depends largely upon the competency of the instrument man assigned to maintain the instruments to a high standard of accuracy, each application has been engineered and field-proved as to its durability, reliability, and ease of maintenance.

At National Works the standard complement of instruments for the blast furnace includes hot-blast temperature indicator and recording controller, top gas temperature, furnace inwall, stove dome, and stove stack temperature recorders, cold-blast temperature indicator, cold-blast pressure indicator and recorder, furnace top pressure recorder, stockline recorders (two per furnace), large bell movement recorder, and cold-blast airflow recorder. The stoves are equipped with combustion air flow and gas flow to each stove, and combustion regulator for each stove.

This paper discusses blast-furnace instrumentation in general, explains the function, and evaluates each of the foregoing applications of instruments.

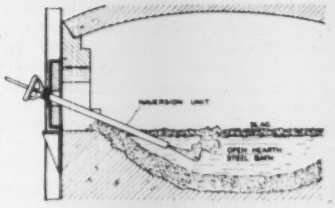
In general, indicators serve the purpose of giving spot data, while recorders are necessary for a thorough analysis during irregular furnace operation. Instruments are placed in locations where information from them will give immediate service to operating personnel.

Radiation Pyrometry in the Steel Industry, by Donald Robertson, Leeds & Northrup Company, Philadelphia, Pa. 1950 ASME Industrial Instruments and Regulators Division—Instrument Society of America Conference paper No. **50—IIR-4** (mimeographed).

THE basis of total radiation pyrometry is the Stefan-Boltzmann law which states that the radiant energy emitted from a black body is proportional to the fourth power of the absolute temperature of that body. A black body is one that will emit the maximum possible amount of energy per unit and area due to its temperature. To better understand this phenomenon, it is helpful to remember that all bodies (excluding transparent ones) are either emitters, reflectors, or a combination of the two. A perfect reflector is one that reflects all radiant energy falling upon it and absorbs none. A black body, on the other hand, will absorb all radiant energy falling upon it and will reflect none. A body that is a 60 per cent emitter will be a 40 per cent reflector and has an emissivity of 60 per cent or an emissivity coefficient of 0.6. Fortunately, ferrous metals have a relatively high emissivity, especially if they have an oxide coating on them and the emissivity is relatively constant over a wide range of temperature.

Therefore a detector that is sensitive to radiant energy in such a way that it can translate radiant energy into some easily measurable quantity, and the emissivity of the surface of the body from which the radiant energy is coming is known, the temperature of the body can be determined.

This type of measurement is well suited for measuring the temperature of moving objects, for measuring surface temperatures, for measuring temperatures in furnaces where contaminating atmospheres



SCHEMATIC DIAGRAM OF A PYROMETER IN A FURNACE

cause thermocouple drift, and for measuring very high temperatures because the radiation sensitive element does not normally attain the actual temperature of the surface being measured but merely some proportion of it.

The application of radiation pyrometry at various locations throughout a steel mill is described along with reasons for such application.

Attenuation of Oscillatory Pressures in Instrument Lines, by A. S. Iberall, National Bureau of Standards, Washington, D. C. 1949 ASME Industrial Instruments—Regulators Division Conference paper No. **49—IIR-5** (in type; published in Trans. ASME, July, 1950, pages 689–695).

A THEORETICAL investigation has been made of the attenuation and lag of an oscillatory pressure variation applied to one end of a tube, when the other end is connected to a pressure-sensitive element. An elementary theory based upon incompressible viscous fluid is first developed. The elementary solution is then modified to take into account compressibility; finite-pressure amplitudes; appreciable fluid acceleration; and finite length of tubing (end effects). Account is taken of heat transfer into the tube. The complete theory is derived in an appendix. The results are summarized in eight graphs in a form convenient for use in computing the lag and attenuation of a sinusoidal oscillation in a transmission tube.

Feedwater Studies

Feedwater Treatment During Early Operation of Steam-Electric Stations, by R. C. Alexander, Department of Water and Power, Los Angeles, Calif., and J. K. Rummel, Mem. ASME, Baltimore, Md. 1949 ASME Semi-Annual Meeting paper No. **49—SA-48** (in type; published in Trans. ASME, July, 1950, pp. 529–532).

BASED upon the experience with five high-pressure steam-generating units installed at the Harbor Steam Plant of the City of Los Angeles during the last six

years, the authors devise some basic practices to follow during early operation of such installations. Their study includes such items as cleaning the feed system, corrosion prevention, chemical control of corrosion, sampling and control tests of the feedwater system, and inspection of equipment.

Heat Transfer

The Response of Thermocouples to Rapid Gas-Temperature Changes, by M. W. Carbon, Jun. ASME, General Electric Company, Richland, Wash.; H. J. Kutsch, Purdue University, Lafayette, Ind.; G. A. Hawkins, Mem. ASME, University of California, Los Angeles, Calif. 1949 ASME Annual Meeting paper No. **49—A-148** (in type; published in Trans. ASME, July, 1950, pp. 655-657).

THIS paper presents practical data which were taken from the main results of a research program dealing with the response of thermocouples to changing gas temperatures. Experimental and theoretical data for the response time of thermocouples ranging in wire size from 0.01 to 0.0005 in. are presented. The experiments were performed over a range of temperatures from 70 F to 950 F, and for air velocities ranging from 0 to 125 fps. All of the experiments were carried out in such a way that the hot junction of the thermocouple was always cooled. An equation is presented for computing the response time for thermocouples fabricated from fine wires and subjected to sudden air-temperature changes. Heat transfer by conduction and radiation were negligible in the experiments performed.

Petroleum

Crude-Oil Flow Characteristics Experienced in Large-Diameter Lines, by L. E. Anderson, Jun. ASME, Stanolind Pipe Line Company, Tulsa, Okla. 1949 ASME Petroleum Mechanical Engineering Conference paper No. **49—PET-13** (in type; published in Trans. ASME, July, 1950, pp. 659-665).

CHARACTERISTICS of crude-oil flow in large-diameter lines have been investigated by gathering data on lines under normal operating conditions. A description of these tests, and a summary of the results obtained are discussed in this paper. From these tests, an exponential equation has been derived to determine capacity or pressure drop for all trunk lines pumping crude oil in the turbulent-flow region. In connection with these flow tests, an investigation was made into the effect of pressure on viscosity in the range of normal pipe-line operating pressures. This effect, which in the past has been assumed to be a negligible one, is shown to be of definite importance.

Surge Problems in Pipe Lines—Oil and Water, by S. Logan Kerr, Mem. ASME, S. Logan Kerr & Company, Philadelphia, Pa. 1949 ASME Petroleum Mechanical Engineering Conference paper No. **49—PET-9** (in type; published in Trans. ASME, July, 1950, pp. 667-678).

THIS paper outlines the work done by the Water Hammer Committee of the Society, outlining the publications involved. A general review and summary are given of water-hammer studies as they can be applied to the petroleum pipeline surge problem.

Hydraulics

Accelerated-Cavitation Research, by W. J. Rheingans, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1949 ASME Annual Meeting paper No. **49—A-140**(in type; published in Trans. ASME, July, 1950, pages 705-724).

THE cavitation-pitting tests described in this paper were made with an accelerated-cavitation machine of the vibratory type. An attempt was made to solve some of the phenomena of cavitation by varying the amplitude of vibration, by varying the depth of submergence of the test specimen in the test liquid, and by using alkalis, acids, and oils for the test liquid. Other tests were made to determine the relative resistance to pitting of recently developed materials and techniques for applying these materials. Results showed that accelerated-cavitation tests can be used to determine some of the mechanics of cavitation, as well as to indicate that some of the newly developed materials might be suitable for use on hydraulic machinery under operating conditions where cavitation occurs.

Power

Effect of Size on the Design and Performance of Internal-Combustion Engines, by C. F. Taylor, Massachusetts Institute of Technology, Cambridge, Mass. 1949 ASME Annual Meeting paper No. **49—A-116** (in type; published in Trans. ASME, July, 1950, pp. 633-645).

THE importance of the problem is outlined and size effects isolated from other effects. Three similar engines were tested at the Sloan Laboratories at M.I.T. Mechanical stresses, volumetric efficiency, heat losses, and wall temperatures are explained as a function of cylinder size. The effects of cylinder size on combustion and fuel requirements are pointed out.

ASME Transactions for September, 1950

THE September, 1950, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics*, contains the following:

TECHNICAL PAPERS

Bending Vibrations of a Pipe Line Containing Flowing Fluid, by Holt Ashley and George P. Haviland. (49—A-22)

The Flow and Fracture of a Brittle Material, by L. F. Coffin, Jr. (49—A-24)

A Method for Determining Mode Shapes and Frequencies Above the Fundamental by Matrix Iteration, by H. I. Flomenhoft. (49—A-21)

Approximate Solutions of Problems of Plane Plastic Flow, by P. G. Hodge, Jr. (49—A-10)

Thermoelastic Stress Around a Cylindrical Inclusion of Elliptic Cross Section, by R. D. Mindlin and H. L. Cooper. (49—A-20)

Bending of an Elliptical Plate by Edge Loading, by W. A. Nash. (49—A-4)

Torsion of Noncylindrical Shafts of Circular Cross Section, by H. J. Reissner and G. J. Wennagel. (49—A-12)

Transverse Vibration of a Two-Span Beam Under the Action of a Moving Alternating Force, by Robert S. Ayre and L. S. Jacobsen. (50—APM-2)

Soap-Film and Sandbed-Mapper Techniques, by A. D. Moore. (50—SA-15)

An Investigation of Ejector Design by Analysis and Experiment, by J. H. Keenan, E. P. Neumann, and F. Lustwerk. (49—A-25)

A Mechanical Analyzer for Computing Transient Stresses in Airplane Structures, by R. L. Bisplinghoff, T. H. H. Pian, and L. I. Levy. (49—A-8)

Elastic-Plastic Analysis of Structures Subjected to Loads Varying Arbitrarily Between Prescribed Limits, by P. S. Symonds and W. Prager. (49—A-3)

Crushing of Aluminum Tubes Under Hydrostatic and Localized Pressure, by E. Creutz. (49—A-23)

Stability of Flow-in a Rocket Motor, by D. F. Gunder and D. R. Friant. (49—A-15)

The Calendering of Plastic Materials, by R. E. Gaskell. (49—A-34)

Matrix Solution for the Vibration of Nonuniform Beams, by W. T. Thomson. (49—A-11)

DISCUSSION

On Previously Published Papers by F. W. Barry; L. H. Donnell and C. C. Wan; T. J. Jaramillo; and C. J. Thorne.

BOOK REVIEWS

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Coal, Coke, and Coal Chemicals

COAL, COKE, AND COAL CHEMICALS. By P. H. Wilson, Jr., and J. H. Wells. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1950. Cloth, 5¾ × 9 in., tables, figures, illus., Abbreviations, Bibliography, Index, ix and 509 pp., $8.

REVIEWED BY J. J. WARD[1]

THIS book fills a long-felt need for a systematic treatise on modern industrial coal carbonization. The standard text on this subject, entitled "Coal Carbonization," was written by H. C. Porter in 1924. Obviously this work has become obsolete because of the great advances made in this field during the past 25 years. The present volume is a successor to Porter's book. It undoubtedly will become the standard text for students of fuel technology, technical workers in the field, and those who are outside of the field but who are interested in coal carbonization for industrial purposes. Furthermore, it will also serve as an excellent introduction to the more comprehensive and advanced volumes on "Chemistry of Coal Utilization" edited by H. H. Lowry and published in 1945. Drs. Wilson and Wells, who were co-contributors to these volumes, have referred to this work consistently throughout their text.

The material in the text follows a logical order of presentation. The subjects of fuel and combustion are presented first, since, as pointed out by the authors, the primary products of the coking industry are fuels, and combustion plays a large part in their manufacture. The origin, classification, and properties of coal are next taken up in chapter 3. The following four chapters, 4 to 8, are devoted to the high-temperature coking process. The characteristics of coal for carbonization and preparation of coal for coking are considered. The methods and problems in coal storage are presented. A discussion of the mechanism of the coking process and characteristics of high-temperature coke complete the treatment of high-temperature coking.

The coal chemicals resulting from high-temperature coking operations are considered in chapters 9 to 12. The subject is separated into a study of gas, ammonia and ammonium salts, light oil, and coal tar. In the chapter on gas, the important subject of gas purification is presented along with a description of the industrial methods of gas conditioning. In the treatment of gas conditioning, as throughout the book, the practical side of the subject is emphasized without slighting the theoretical considerations. In the discussion on refining light oil and coal tar, the older batch processes are described as well as the recent continuous methods.

Coal carbonization for gas manufacture and low-temperature carbonization processes are discussed in chapters 13 and 14. The authors have discussed the Curran-Knowles oven after considering the low-temperature processes, pointing out that this oven is the only one other than the conventional slot-type by-product oven in which coal is coked at high temperatures.

Economics and trends in the coal-carbonization industries are considered in the last two chapters, fifteen and sixteen, of the volume.

The book is singularly free of typographical errors and measures up to the high standards of the Chemical Engineering Series.

[1] Assistant Supervisor, Chemical Research Division, Battelle Memorial Institute, Columbus, Ohio.

The American Economic System

THE AMERICAN ECONOMIC SYSTEM. By Frank D. Newbury. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1950. Cloth, 6 × 9 in., tables, graphs, Review Questions, Index, xii and 558 pp., $5.

REVIEWED BY H. P. HAMMOND[2]

THIS book is intended for three groups of students: (1) third or fourth-year students in professional schools and colleges, particularly students of engineering and physical science; (2) students in more general college courses; (3) businessmen, college graduates, and other students outside of colleges. Before appearing in its present published form, the substance of the book was used in preliminary draft form with evening classes of businessmen and with a class of third-year engineering college students. It is the result of long continued study and trial in the effort to produce a book having a realistic approach to the American economic system and its problems. It has the purpose of leading not only to an understanding of that system but of ability to solve its practical problems in business and professional life.

The book breaks definitely away from the stereotyped "classical" approach to the study of economics as presented in conventional textbooks which are so often pursued with indifferent or negative results by students of engineering or related technical curricula.

It devotes a minimum of time to the orthodox static theory of economics; only such attention is devoted to it as is needed to develop, by contrast, knowledge of the more realistic phenomena and principles of the dynamic American economic system.

After this preliminary treatment of static theory, the book presents a clear and vivid picture of the dynamic economics of the modern world of science and industry with its rapidly changing economic conditions. The text material is liberally illustrated with examples drawn from industrial case histories and is thereby made of vital interest to the reader.

The nature of the philosophic approach to certain phases of modern American economics is illustrated by the following excerpts:

(1) "The Nature of Actual Markets. The real world we are about to study is a dynamic world in which disturbance and uncertainty are the normal condition, a world in which changes occur so rapidly and continuously that static equilibrium is never attained; it is a world in which capital and management are the dynamic factors of progress. It is a world of new inventions, new products, new indus-

[2] Dean, School of Engineering, The Pennsylvania State College, State College, Pa. Mem. ASME.

tries, and new markets; a world in which man's acquisitive spirit and dissatisfactions and the opportunities for profit are the driving forces that create more production for less labor, with lower costs and higher real wages; in short, economic progress.

(2) "The Role of Business Profits. One of the conditions of static economy (as described in chapter 3) is that no surplus can exist. No factor of production can receive more than the exchange value of its contribution to production. In sharp contrast, a progressive, dynamic society must produce a substantial surplus or there can be no great progress. It is out of surplus goods and surplus time—after necessitites are provided for—that better tools, better methods, better products develop. And money profits of business firms are one form in which this surplus is produced in dynamic society.

"Making a profit should not be looked on as a social crime. As a matter of fact, the managements which do not make a profit are the social and economic sinners.

(3) "Production Per Man-Hour. High productivity—a high rate of production—is the most significant characteristic of American industry. The United States has developed the highest productivity that has been achieved by any nation. It is estimated that in the more normal prewar years the United States, with about seven per cent of the world's population, produced 35 per cent of the world's goods. In 1948, with much of the world outside of the United States producing at a subnormal rate, the United States produced half of all the goods produced. High productivity is, in modern nations, what fertile land was in the first decades of the nineteenth century—the foundation of a prosperous, wealthy economy, and the road to economic progress and affluence."

References to economic phenomena are liberally documented throughout the book. Discussions of principles and trends are illustrated by tabulations of data and their graphic presentations. These diagrams are very well conceived and drawn. Ideas conveyed by the text are readily grasped, which aids materially in reading the text.

A valuable feature of the book is a two-or-three-page summary of major points which is placed at the end of each chapter. There is also at the end of each chapter a set of review questions and problems which may be assigned by the instructor to be answered or solved by the student so that he must be an active participant in the conduct of the course, an experience with which students of engineering and science are familiar. This feature of the text is another characteristic which commends it for engineering or science-school use by removing from it the criticism of abstract treatment and course conduct which is so prevalent in relation to textbooks on economics.

In order to adapt the book to the time limitations of a course running for a single semester, the author suggests possible omissions up to approximately 20 per cent of the total amount of text material, the suggested possible omissions being those portions of the text that deal with orthodox static theory, the "Behavior of Money," and "Forecasting Business Activity."

The author, being a distinguished engineer, as well as a practicing economist, has accomplished admirably the aim of producing a text suited to both the interests and the needs of students and practitioners of engineering and science. It should prove valuable especially for undergraduate and postgraduate students of engineering.

Books Received in Library

ASTM SPECIFICATIONS FOR STEEL FLAT PRODUCTS, sponsored by ASTM Committee A-1 on Steel, March, 1950. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 508 pp., diagrams, tables, $2.25. Specifications pertaining to steel plate, sheet, and strip materials are brought together in this publication for convenient reference. They are broadly classified as follows: steel for structural purposes; steel for boilers and pressure vessels; corrosion-resisting steel; wrought-iron plate and sheet; metallic-coated iron and steel sheets. The usual numerical list is also included.

DYNAMIQUE GÉNÉRALE DES VIBRATIONS. By Y. Rocard. Second edition revised and enlarged. Masson & Cie, Éditeurs, Paris, France, 1949. Paper, 6¼ × 9 in., 439 pp., diagrams, charts, tables, 1900 fr. This comprehensive work deals with the dynamics of vibrating systems. Part 1, comprising the first three quarters of the book, covers mechanical and electrical systems: simple pendulums, damping, electromechanical analogies, impedance problems, shock effects, spring systems, band-pass filters, auto-oscillation conditions, and so on. Part 2 covers basic aspects of acoustical systems: wave propagation under various conditions, loud speakers, microphone setup.

ESTIMATING AND PLANNING FOR ENGINEERING PRODUCTION. By P. S. Houghton. Blackie & Son, Ltd., London, England, and Glasgow, Scotland, 1950. Linen, 6 × 9 in., 366 pp., diagrams, charts and tables, 25s. All aspects of production planning are covered from the estimating of material requirements to the matter of pricing and sales. The bulk of the book, however, is devoted to the processing of metals by machining. Some 200 tables are given to assist production personnel to plan each machining operation so that full use is made of both tool and machine. Examples are given to illustrate the use of these tables.

GATES AND RISERS FOR CASTINGS. By P. Dwyer. Third edition. Penton Publishing Co., Cleveland, Ohio, 1949. Cloth, 6 × 9¼ in., 375 pp., illus., diagrams, charts, tables, $6. Written for the foundryman, this book considers the functions and applications of gates and risers in the production of gray iron, brass, bronze, aluminum, steel, and malleable-iron castings. In addition to descriptions of practically all types of gates and their application, related features are also presented. The text is based on the varied practical foundry experience of the author as well as on the published literature on the subject.

HEAT AND TEMPERATURE MEASUREMENT. By R. L. Weber. Prentice-Hall, Inc., New York, N. Y., 1950. Cloth, 5¾ × 8½ in., 422 pp., illus., diagrams, charts, tables, $5. ($6.65 text edition.) This book describes measurement methods and includes the theoretical principles necessary for their appreciation, intelligent use, and extension. Emphasis is on experimental methods rather than on thermodynamic theory. Part 1 presents the physical principles. Part 2 outlines the procedures for 29 laboratory experiments and includes brief discussions of the theory and photographs of typical arrangements of apparatus. The Appendix contains data tables.

INDUSTRIAL MATERIALS HANDLING, original manuscript by C. H. Barker, Jr., revised and rewritten by I. M. Footlik, C. F. Yarham, and J. F. Carle. Lincoln Extension Institute, Cleveland, Ohio, 1950. Linen, 5½ × 8¼ in., 381 pp., illus., diagrams, charts, tables, $4.75. A comprehensive and basic treatment of materials handling, based on information obtained from experts in all aspects of the field. Following a history and survey of the field, the fundamentals of materials-handling operations are considered. Various types of equipment are then described in detail. The problems of unit loads and plan layout are also dealt with. Applications of the data which are presented in the early part of the book are described in the concluding sections.

INTRODUCTION TO EXPERIMENTAL STRESS ANALYSIS. By G. H. Lee. John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd., London, England, 1950. Cloth, 6 × 9¼ in., 319 pp., illus., diagrams, charts, tables, $5.50. Theory, instrumentation, and basic techniques are covered for the most commonly used methods: mechanical and electrical strain gages, with particular attention to the resistance-wire strain gage, the photoelastic method, brittle-lacquer techniques, the membrane and electrical analogies, the Beggs deformeter, and other miscellaneous methods. The final chapter deals with the evaluation of experimental errors and the transmission of these errors through computational operations.

INTRODUCTION TO THE TRANSFER OF HEAT AND MASS. By E. R. G. Eckert with an appendix on property values by R. M. Drake, Jr., McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 284 pp., illus., diagrams,

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

charts, tables, $4. Based on a text originally published in German, this book provides an understanding of the physical processes and laws connected with heat and mass transfer. Evaporation and condensation of water vapor are used as the basis for the treatment of heat transfer. The concept of the boundary layer as the place where most heat transfer occurs is stressed. Many heat-transfer problems are solved mathematically. Such new topics as regenerative heat exchangers, heat transfer at high velocities, and studies with the Zehnder-Mach interferometer are included.

MOTOR OILS AND ENGINE LUBRICATION. By C. W. Georgi. Reinhold Publishing Corporation, New York, N. Y., 1950. Cloth, 6 × 9¼ in., 514 pp., illus., diagrams, charts, tables, $8.50. The purpose of this book is to present a classified summary of some of the existing information on the subject. Part 1 deals with the manufacture of motor oils, their chemical and physical properties, and means and methods of testing and evaluating performance characteristics. Part 2 is devoted to the application of motor oils and the relation of oils and lubrication to engine design, operation, maintenance, breakdowns and failures. Numerous references have been made to published material although no attempt was made to compile a complete reference list.

NEUERE FESTIGKEITSPROBLEME DES INGENIEURS. By K. Marguerre. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Cloth, 6¼ × 9¼ in., 253 pp., illus., diagrams, charts, tables, bound, 25.50 Dm. The six main sections of this book deal, respectively, with the following major problems in the strength-of-materials field: experimental methods of stress determination, stress problems which involve the theory of elasticity (two sections), an introduction to vibration mechanics, the solution of vibration problems, and stability problems having a close relation to the problem of vibration.

NORMUNGSZAHLEN. (Wissenschaftliche Normung 2.) By O. Kienzle. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Bound and paper, 5½ × 8 in., 339 pp., diagrams, charts, tables, bound, 25.50 Dm; paper, 22.50 Dm. This book contains both the theoretical and practical aspects of standard numbers. In the first part the mathematical relationship of numbers and systems of numbers is considered. The second part is devoted to applications, such as measurements, productivity, weights, and the field of machinery construction. A bibliography and a list of related German standards are also included.

UN NOUVEAU MANOGRAPHE PHOTO-ELECTRIQUE. (Publications Scientifiques et Techniques du Ministère de l'Air, Notes Techniques No. 32.) By P. Barret. Au Service de Documentation et d'Information Technique de l'Aéronautique, Paris, 1950. Paper, 7 × 10½ in., 14 pp., illus., diagrams, 180 fr. A manograph or indicator is described in which the action of a diaphragm, responding to the engine-cylinder pressure, controls the width of a slit, which in turn modulates a beam of light. These modulations are registered by an electronic system comprising a photoelectric cell and an oscillograph. Emphasis is on the variable-slit feature which largely eliminates parasitic vibrations.

POCKET ENCYCLOPEDIA OF ATOMIC ENERGY. Edited by F. Gaynor. Philosophical Library, New York, N. Y., 1950. Linen, 5½ × 8¾ in., 204 pp., diagrams, charts, tables, $7.50. This book presents a comprehensive collection of brief explanations and definitions of concepts and terms in the field of nuclear physics and atomic energy. In addition, brief biographical sketches of outstanding workers in the field are included as well as descriptions of important nuclear-research laboratories, power plants, and installations. German equivalents are given for a great many of the terms defined.

PRINCIPLES OF ENGINEERING ECONOMY. By E. L. Grant. Third edition. Ronald Press Co., New York, N. Y., 1950. Cloth, 6 × 9¼ in., 623 pp., charts, tables, $5. Useful as a reference for the practicing engineer and the industrial manager as well as a text for engineering students, this book discusses the principles which govern the economic aspects of an engineering decision. Among the new material in this edition are a consideration of prospective price changes, discussion of the relation of income taxes to economy studies, and a new treatment of the theoretical aspects of replacement economy. More than two thirds of the book has been re-written and most of the 400 problems are new.

PROPERTIES OF METALS AT ELEVATED TEMPERATURES. By G. V. Smith. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 401 pp., illus., diagrams, charts, tables, $7. This book collects and correlates the results of twenty-five years of research work on the effect of temperature on the properties of metals. The initial chapters deal with the nature of plastic deformation and fracture of metals from a metallurgical viewpoint. Next, the test apparatus and test procedures employed in evaluating metals for service at elevated temperatures are described. The effects of such variables as chemical composition, manufacturing practice, and heat-treatment are then discussed. The questions of sealing and changes in microstructure are also considered. A final chapter deals with the problem of design for service at elevated temperatures. Numerous illustrations, an appendix with useful data, and an extensive bibliography are also included.

RAPID TRAVERSE TABLES. By L. J. Goldsmith. Wm. C. Brown Company, Dubuque, Iowa, 1950. Stiff paper, 5½ × 8½ in., 540 pp., diagrams, tables, $5. The products of the natural sines and cosines of angles multiplied by the numbers from one to nine are tabulated for each minute of angle from 0°01′ to 89°59′. The values listed are accurate to five figures following the decimal point. The tables are particularly applicable to problems in which the hypotenuse and an adjacent angle of a right triangle are known, such as are found in trigonometry, applied mechanics, and surveying. A special rapid calculator devised for use with the tables is included.

RECOMMENDED PRACTICES FOR RESISTANCE WELDING. C1.1-50. American Welding Society, New York, N. Y., 1950. Paper, 6 × 9 in., 60 pp., diagrams, charts, tables, $1. This new edition represents a modification and expansion of the Standard originally issued in tentative form in 1946. It includes welding schedules for spot and seam-welding of mild and medium-carbon steels, low-alloy steels, stainless steels, nickel, Monel, Inconel, and magnesium alloys. Recommended practices for projection welding cover low-carbon and stainless steels. Flash-welding data are provided for low and medium-forging-strength steels. A section on methods of testing resistance welds is also included.

REPORT ON THE STRENGTH OF WROUGHT STEELS AT ELEVATED TEMPERATURES. (Special Technical Publication No. 100.) Prepared by R. F. Miller and J. J. Heger. American Society for Testing Materials, Philadelphia, Pa., 1950. Paper, 8½ × 11 in., 109 pp., charts, $3. This report is a graphical presentation of published information on the subject. Tensile, creep, and rupture properties of the standard commercial grades are shown, together with the sources from which they were obtained. The first section covers plain carbon and alloy steels containing molybdenum and up to 3 per cent chromium; the second deals with the ferritic and austenitic steels containing more than 5 per cent chromium. Applicable ASTM standards are included.

STEAM TURBINES AND THEIR CYCLES. By J. K. Salisbury. John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd., London, England, 1950. Linen, 6 × 9¼ in., 645 pp., illus., diagrams, charts, tables, $9. Of particular interest to those concerned with the application of steam turbines in power plants, this book provides a detailed treatment of the following topics: basic thermodynamics and the fundamentals of steam-turbine design; the regenerative cycle and the calculation of heat balances; cycle evaluation methods, including the simple and accurate calculation of losses in the feedwater-heating cycle; data and methods for determining steam rates and heat rates of steam turbines of any size. The appendix includes many useful tables and a selected list of references.

STRENGTH OF MATERIALS. By J. E. Boyd, revised by S. B. Folk. Fifth edition, McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6¼ × 9¼ in., 417 pp., illus., diagrams, charts, tables, cloth, $4.25. In the new revision of this standard text, a special attempt is made to emphasize the fundamentals of the theory and to accept the process of analysis in the application of mathematics to strength of materials. The utilization of fundamental ideas, physical constants, and reasonable stresses with a minimum of memory formulas is intended to provide the student with a useful working knowledge of the subject. Revisions have been made with regard to recent developments and present-day interpretation.

SYMPOSIUM ON EFFECTS OF LOW TEMPERATURES ON THE PROPERTIES OF MATERIALS. (Special Technical Publication No. 78.) American Society for Testing Materials, Philadelphia, Pa., 1950. Paper, 6 × 9 in., 62 pp., illus., diagrams, charts, tables, $1.50. This symposium of four papers and discussions brings together some of the existing knowledge of the low-temperature use of plastics, elastomers such as rubber, nonferrous metals, and metal welds. Suggestions for future work in this field are outlined.

TRAFFIC DICTIONARY. By G. T. Stufflebeam. Fourth edition, enlarged and revised. Simmons-Boardman Publishing Corporation, New York, N. Y., 1950. Fabrikoid, 4½ × 6¼ in., 292 pp., $3.75. Definitions are given for more than 1800 everyday traffic terms; 1200 abbreviations are identified; and the names and reporting code marks are listed for 1000 North American railroads, private car lines, and steamship lines. The subject matter includes the preparation, recording and handling of shipments, warehousing, claim procedures, export and import transactions, and rules and regulations. New material has been added in this enlarged edition.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly, to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING. The following Case Interpretation was revised at the Committee meeting June 23, 1950, and approved by the Board August 24, 1950.

CASE No. 941 (Reopened)

(Special Ruling)

Inquiry: Is it permissible to construct welded unfired pressure vessels in accordance with Par. U-68, of high tensile manganese molybdenum steel conforming to ASTM Specifications A 204-38, modified as follows:

Carbon, max, per cent	0.22
Manganese, max, per cent	1.50
Phosphorus, max, per cent	0.04
Sulphur, max, per cent	0.04
Silicon, per cent	0.15-0.30
Molybdenum, per cent	0.40-0.70
Tensile strength, psi	90,000-105,000
Yield point, min, psi	55,000
Elongation, min, in 2 in., per cent	2,300,000 / tens str

Reply: It is the opinion of the Committee that it is permissible to construct welded unfired pressure vessels of the steel specified in the inquiry under the provisions of Par. U-68 with the following additional provisions:

(1) The maximum thickness of shell or head shall be $2\frac{1}{2}$ in. Plate for shells or heads over $\frac{5}{8}$ in. in thickness shall be normalized at 1650 F to 1700 F;

(2) The maximum allowable working stress shall be 18,000 psi if based on a factor of safety of five, or 22,500 psi if based on a factor of safety of four;

(3) The service temperature shall not exceed 450 F;

(4) The material shall be preheated to as high a temperature as practicable and held there throughout the welding operation;

(5) Weld reinforcement shall be removed;

(6) After stress relief the vessel shall be cooled slowly in the furnace to less than 600 F with the furnace doors closed;

(7) Welded test plates shall be made from the same lot of material and receive the same heat-treatment as the vessel itself.

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code, to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennally the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ]. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

TABLE P-5 Under Seamless Alloy Steel, below Grade P8b, insert the following stresses for Specification SA-158 Grade P8d:

−20 to 650	700	750	800	850	900
15000	15000	14600	14300	14000	13400
950	1000	1050	1100	1150	1200
12300	10000	8000	6000	4600	3600

TABLE P-7 In Plate Steels section, under Carbon Steel, in SA-30 Firebox, Gr. A line, change Specified minimum tensile from "52000" to "55000." In Pipe and Tubes section, under Seamless Alloy Steel, in SA-158 P8d line, change the 1100 F stress from "8000" to "6000." Under Forgings Alloy Steel add the following stresses for Specification SA-182 Grade F22:

For metal temperatures not exceeding deg F −20 to 650	700	750	800	850	900
14000	14000	14000	13500	12000	10200
950	1000	1050	1100	1150	1200
8250	6250	4800	3700	2700	1950

Material Specifications 1949

SA-217 In Table 1, in Grade WC6 column drop "1.00 to 1.50" from the Nickel, per cent line to the Chromium line, leaving the Nickel line blank.

Unfired Pressure Vessels 1949

TABLE U-2 In Plate Steels section under Carbon Steel, in SA-30 Firebox Gr. A line, change Specified minimum tensile from "52000" to "55000." In Pipe and Tubes section, under Seamless Alloy Steel in SA-158 P8d line, change the 1100 F stress from "8000" to "6000." Under Forgings Alloy Steels add the following stresses for Specification SA-182 Grade F-22:

For metal temperatures not exceeding deg F −20 to 650	700	750	800	850	900
14000	14000	14000	13500	12000	10200
950	1000	1050	1100	1150	1200
8250	6250	4800	3700	2700	1950

NOTE: For use in Table UG-23, the above stresses might be increased by using the multiplying factor 1.25

Unfired Pressure Vessels 1950

TABLE UG-23 In Plate Steels section, under Carbon Steel, in SA-30 Firebox, Gr. A line, change Specified minimum tensile from "52000" to "55000." (See Note under Table U-2).

PAR. UG-46 Add as new paragraph:

UG-46(e) Manholes of the type in which the internal pressure forces the cover plate against a flat gasket shall have a minimum gasket bearing width of $\frac{11}{16}$ in.

PAR. UG-47(f) Revise to read:

(f) The maximum pitch for welded stays and for screwed stays with ends riveted over shall be $8\frac{1}{2}$ in.

PAR. UG-98. Revise as follows:

UG-98 *Maximum Allowable Working Pressure.* The maximum allowable working pressure is the maximum pressure permitted at the top of a vessel in its normal operating position at the operating temperature specified for that pressure. It is the least of the values found for allowable working pressure, for all essential parts of the vessel as determined by the rules and formulas of this Code, including any combination of loadings listed in Par. UG-22 which can occur, and adjusted for the difference in static head between the part considered and the top of the vessel.

PAR. UG-99(b) Revise as follows:

(b) Except as required or permitted other-

wise in the Code, vessels designed for internal pressure shall be subjected to a hydrostatic test pressure of at least $1^1/_2$ times the maximum allowable working pressure as determined by Par. UG-98. In the calculations, the actual thickness (including thickness allowances for corrosion) of each vessel element, such as head, shell, nozzle, bolted flanged connection, reinforcements, etc., shall be used and the value of S shall be taken from Table UG-23 for the temperature corresponding to the temperature of the vessel during the test. The inspector shall reserve the right to require the manufacturer or designer to furnish the calculations used in determining the maximum allowable hydrostatic test pressure for any element of the vessel.

PAR. UG-99(c) Delete and reletter subsequent subparagraphs.

PAR. UG-100(a) Revise as follows:

UG-100. *Pneumatic Test.*[1] (a) The pneumatic test prescribed in this paragraph shall be used in lieu of the hydrostatic test prescribed in Par. UG-99 as follows:

(1) for vessels that are so designed and/or supported that they cannot safely be filled with water.

(2) for vessels, not readily dried, that are to be used in services where traces of the testing liquid cannot be tolerated and the parts of which have previously been tested by hydrostatic pressure to $1^1/_2$ times the maximum allowable working pressure of the vessel.

PAR. UG-100(b) Revise as follows:

(b) The pneumatic test pressure shall be at least $1^1/_4$ times the maximum allowable working pressure as determined by Par. UG-98. In the calculations, the actual thickness (including thickness allowances for corrosion) of each vessel element, such as head, shell, nozzle, bolted flanged connection, reinforcements, etc. shall be used and the value of S shall be taken from Table UG-23 for the temperature of the vessel during the test. The inspector shall reserve the right to require the manufacturer or designer to furnish a complete set of the calculations used in determining the maximum allowable hydrostatic test pressure for any part of the vessel.

PAR. UG-125(f) Revise as follows:

(f) Pressure indicating gages, if used, shall preferably be graduated to approximately double the operating pressure, but in no case to less than 1.2 times the pressure at which the relieving device is set to function.

PAR. UG-127(e) Delete last two sentences of footnote[2] and add as subparagraphs:

(8) The contents of the vessel are clean fluids, free from gumming or clogging matter, so that accumulation in the space between the valve outlet and the rupture disk (or in any other outlet that may be provided) will not clog the outlet.

(9) The services are such that atmospheric temperatures are not exceeded.

PAR. UG-127(e)(7) Sixth line. Change "shall" to "will."

PAR. UG-129(d) Revise footnote[1] as follows:

[1]The marking may be coded and identified with the marking given on the certificate supplied with each rupture disk.

PAR. UG-130(2) Tenth line. Change "the above" to "safety valves to which the Code symbol is applied."

PAR. UW-14(c) Third line. Change "should" to "shall."

PAR. UW-15(c)(3) Delete last two lines and substitute: "but shall conform to Par. UW-15 (b) and Par. UG-41."

PAR. UW-15(d) First line change "flanges" to "saddles."

PAR. UW-19(a)(3) Revise to read:

(3) The provisions of Par. UG-47 and of Par. UG-49 shall be followed.

PAR. UW-50 Revise as follows:

UW-50 *Hydrostatic and Hammer Tests.* (a) Fusion-welded pressure vessels, except enameled vessels and vessels that have been both stress-relieved and radiographed, shall be hammer-tested at the same time as the hydrostatic test or its permissible equivalent, as prescribed in this paragraph.

(b) The hammer test shall be made by striking the shell plates at intervals of 6 inches on both sides of the joint for the full length of each welded joint. The plates shall be struck a swinging blow with a hammer whose weight in pounds is approximately equal to ten times the shell thickness in inches, but not greater than 10 lb. Plates $^3/_{16}$ in. or less in thickness need not be hammer-tested. The edges of the hammer shall be rounded so as to minimize defacement of the plate.

(c) Vessels that are to be hydrostatically tested in accordance with Par. UG-99 shall be given a hammer test when required in (a) while the hydrostatic test pressure on the vessel is between 1.25 and 1.5 times the maximum allowable working pressure, provided the vessel diameter is not greater than 12 ft. and/or the height when tested in a vertical position is not greater than 20 ft. All vessels outside these limits shall be given any required hammer test while empty and not under pressure.

(d) Vessels that are to be pneumatically tested in accordance with Par. UG-100 shall be given a hammer test when required in (a) before the pneumatic test is made and while the vessel is empty and not under pressure. Following the hammer test, all joints shall be examined for leaks by a soapsuds or equivalent test while under an air pressure not exceeding 2 psi, except that in lieu of the 2 psi soap test, any other preliminary leakage detecting test may be used on shop-tested vessels. The preliminary test at 2 psi may be omitted on shop-tested vessels that are to be used in services where traces of the testing liquid cannot be tolerated and that cannot readily be dried.

(e) A vessel required to be stress-relieved after welding repairs have been made shall again be tested in compliance with the requirements of this paragraph, and if it passes the test the inspector shall accept it. If it does not pass the test, the inspector can order supplementary repairs, or, if in his judgment the vessel is not suitable for service, he may permanently reject it.

PAR. UW-51(b) Revise table as follows:

Plate thickness, in.	Maximum thickness of Reinforcement, In.
up to $^1/_2$, incl.	$^1/_{16}$
over $^1/_2$ to 1, incl.	$^2/_{32}$
over 1.	$^1/_8$

PAR. UW-52(a) Add at end:

The length of a spot radiograph need not exceed 8 in.

PAR. UR-25(c) Delete and reletter the paragraphs (d) and (e).

PAR. UA-45(a) Third line. After ASA B16e-1939, insert reference[1] to footnote as follows:

[1] The ratings in this standard are based on the hub dimensions given or in the case of integral construction the minimum thickness specified for steel flanged fittings. If fabricated nozzles are employed, using rings instead of hub flanges, the strength of the design calculated by the rules in this Appendix shall be at least equal to that of the corresponding ASA size.

PAR. UA-47(c) in paragraph side-head, change "*Load*" to "*Loads*." Revise first sentence to read:

The bolt loads used in the design of the flange shall be the values obtained from the following formulas:

Give the formula for Atmospheric temperature conditions the number (6)

TABLE UA-47.1 In box under title, in first line, change "Design Stress" to "Design Seating Stress." Revise last sentence to read:

The design values and other details given in this table are suggested only and are not mandatory.

In body of table for Flat metal jacketed asbestos filled, 4–6% chrome, change m value from "4.00" to "3.75" and y value from "8800" to "9000."

In column for Facing limitations opposite Flat metal jacketed asbestos filled, insert "1a and 2*" and draw horizontal line above.

Beneath table add footnote:

* The surface of the gasket having a lap should be against the smooth surface of the facing after the removal of the nubbin.

TABLE UA-47.2 Under title insert:

(The design values and other details given in this Table are suggested only and are not mandatory.)

In right hand cut at bottom of page remove the nubbin below the gasket. (By previous correction the word "*Nubbin*" was changed to "*Gasket Contact Face*" and below the sketch was inserted "*For* $b_o \leq {}^1/_4$".")

Announcement

Part UHA, Code for Unfired Pressure Vessels, Section VIII, 1950 "Supplementary Requirements for Vessels Constructed of High-Alloy Steels," dated July, 1950, has been approved as part of this Section.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Declining Freshman Enrollment May Cause Shortage of Engineers

THE engineering profession has an obligation to be concerned about two dangerous tendencies in engineering education: (1) The alarming decrease in the enrollment of freshman engineering students in the face of increasing demand for engineers; and (2) the effective utilization by the Armed Forces of men who have already completed their engineering education, Thorndike Saville, dean, college of engineering, New York University, New York, N. Y., recently warned in his annual report.

Unless the size of engineering freshman classes can be increased appreciably, Dean Saville stated, a serious shortage of young engineers may develop in the next few years. Because of the widespread publicity given by the daily and professional press to the news release on "Employment Outlook for Engineers" issued by the Bureau of Labor Statistics, which called attention to a large number of engineering students graduating in June, 1950, and presenting a pessimistic outlook on immediate job availability, many high-school students well qualified for engineering careers are not enrolling in the engineering schools this fall.

Dean Saville pointed out that more recent studies by the Manpower Survey Committee of the Engineers Joint Council and the Manpower Committee of the American Society for Engineering Education have produced data that shows that even without the developing war situation, engineering graduates would be in short supply by 1952 if not before.

Dean Saville said that "The future looks bright for engineering graduates but may be dark for the national efforts dependent upon engineers." He estimated that 36,000 freshman engineering students would enroll this fall and that this number would produce about 20,000 graduates in 1954.

"The cold and hot wars, attended by partial military mobilization and marked expansion in war industries have since last June rapidly absorbed any real surplus of June, 1950, engineering graduates. The freshman engineering classes are approaching prewar proportions, and are already smaller than would have been the case if the prewar gradient of increase in engineering-college freshmen had been maintained," he said.

Concluding with a plea for effective utilization of engineering man power, Dean Saville said that the engineering profession must take an interest in how our government's man-power allocations are made. In any extended military effort engineers must be trained and then allocated to military and industry services where their training can be most effective. In view of the increasing applications of engineering, there can be no "short cuts" to engineering education.

Dr. Kamo Visits U. S. A.

THE reconstruction of Japanese peacetime industry to a prewar state of efficiency will be a matter of years, according to Masawo Kamo, Hon. Mem. ASME, and professor-emeritus of mechanical engineering at the Tokio Imperial University, Tokio, Japan.

Dr. Kamo, who was chairman of the Organizing Committee of the World Engineering Congress held in Japan in 1929, visited the offices of The American Society of Mechanical Engineers, following his participation in the Fourth World Power Conference recently concluded in London. While in New York, Dr. Kamo renewed old friendships and visited several American industrial plants.

Commenting on the engineering profession in Japan, Dr. Kamo said that it was composed primarily of 22 engineering societies with a combined membership of 150,000 engineers. The Japanese Society of Mechanical Engineers has a membership of about 25,000.

Most engineers in his country, Dr. Kamo continued, were too preoccupied to give much thought to the international aspects of the engineering profession, and as a result, the Japanese Federation of Engineering Societies, under whose aegis Japan in 1929 sponsored the World Engineering Congress held in Tokio, has not been able to maintain the enthusiasm so evident twenty years ago.

Imperial University Most Popular

The Tokio Imperial University, according to Dr. Kamo, is by far the most popular engineering school in Japan. Engineering students who are not fortunate enough to matriculate there by winning in the competitive entrance examinations, have several other excellent engineering schools to turn to. Few come to the United States because sponsors are necessary and these are difficult to secure. As in the United States, a period of six to ten years of actual experience in industry is required before a graduate attains a recognized professional status. University training is not essential for membership in Japanese engineering societies. Admission committees do not bar men who have come up through industry.

With regard to economic status, Dr. Kamo said, smilingly, that in Japan, too, young men feel that they are not paid enough for their services.

Served as U. S. Technical Adviser

When the U. S. forces arrived in Japan, Dr. Kamo served as technical adviser to U. S. General Headquarters and recommended measures which would insure most effective utilization of Japanese industrial facilities. In 1948 he established an engineering faculty of HOSEI University, an old private institution with a brilliant record of more than 70 years in the field of education.

In a letter to the Society prior to his visit, Dr. Kamo expressed his appreciation of Mechanical Engineering which he was receiving regularly since the resumption of international postal service following the war. Mechanical Engineering, he said, has kept him informed of new developments in mechanical engineering and in the results of significant research projects, and particularly as to what was happening to his friends in the ASME.

Plans for ASCE Centennial in 1950 Under Way

THE American Society of Civil Engineers will celebrate the centennial of its founding by an exposition and convocation of engineers during the period July 1–Sept. 30, 1952. The celebrations will be held in the Museum of Science and Industry, Jackson Park, Chicago, Ill.

The American Society of Mechanical Engineers and the other constituent societies of the Engineers Joint Council have accepted an invitation to join the ASCE in its centennial celebration. Each society is planning to hold a full-scale meeting during the convocation period. In addition, nearly 100 national, international, and regional engineering societies and engineering schools plan to participate. It is expected that the greatest convocation of the engineering profession ever to be scheduled will take place between Sept. 3–13, 1952. As part of the celebration a new permanent educational exhibit designed to tell the story of engineering contributions during the past 100 years will be erected in the Museum of Science and Industry.

The year 1952 as the centennial year of the founding of the first great engineering society in America will be an appropriate time to bring to the public the full story of engineering.

American Opportunity

IN accounting for the higher productivity noted in fifteen representative internal-combustion-engine manufacturing plants in the United States, the British productivity team representing the British internal-combustion industry put its finger on one of the basic truths of American industrial life. The British team observed that "sentiment and personal considerations" had no bearing on the selection of men for managerial positions in the American plants, and that the fact that an individual had attained a particular position was no guarantee that he would hold it indefinitely if he proved not to be man enough for the job.

The report also noted that American workers on all levels of responsibility had an "acute realization of the value and importance of time." On many occasions individual members of the British team were told by their opposite numbers, "hours are not important; it is what you do with them that matters," the report states.

British Commonwealth Conferences

ENGINEERS of the British Commonwealth of Nations are co-ordinating their activities through the Commonwealth Engineering Institutions Conferences, the second of which was held in Johannesburg, South Africa, April 11–25, 1950, according to the July issue of *The Engineering Journal* of The Engineering Institute of Canada.

The Conference is, in effect, an international Engineers Joint Council in which engineering institutions of Australia, Canada, Great Britain, New Zealand, and South Africa come to an understanding on such matters as qualifications for grades of membership, exchange of membership privileges, collaboration with European and American engineering bodies, relations with UNESCO, and training opportunities in Britain for overseas junior engineers.

The first of the Commonwealth Conferences was held in London in 1946. It grew out of the idea that engineers of all the commonwealth nations would benefit if their leaders had an opportunity to discuss common problems, to review past methods and performance in the light of changing conditions, and to exchange experiences and ideas.

Welding Prize Competition Announced

THE Eutectic Welding Alloys Corporation has announced a $1000 prize competition for technical papers having to do with research and development in the field of nonfusion welding processes. Three prizes will be awarded: $500, first prize; $300, second prize; $200, third prize. The competition is open to welding engineers, research men, metallurgists, instructors, and students.

For rules of competition, write to Eutectic Welding Alloys Corporation, 40 Worth Street, New York 13, N. Y.

Tenth Book in Monograph Series Published

THE tenth and latest book in the Engineering Societies Monograph series has just been published by the McGraw-Hill Book Company Inc., New York, N. Y. The book is "Theory of Flow and Fracture of Solids," by A. Nadai, Fellow ASME, consulting mechanical engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa.

The work is the first of a two-volume revision and expansion of Dr. Nadai's pioneer work, "Plasticity," which was the first volume published as an Engineering Societies Monograph when the series started in 1931. The book contains 572 pages and sells for $10.

The Engineering Societies Monograph series is a joint project of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the McGraw-Hill Book Company, Inc. Books in the series are those judged to possess usefulness to engineers or industry, but are not likely to be published commercially because of their highly specialized nature and, therefore, limited sale. The series aims to make available books of high technical quality to set a standard for American engineering literature.

Some of the books in this series are: "Hydraulics of Open Channels," by Boris A. Bakhmeteff (1932); "Theory of Elasticity," by Stephen Timoshenko (1934); and "Fluid Mechanics for Hydraulics," by Hunter Rouse (1938).

WILLIS H. CARRIER CELEBRATES A MILESTONE

(Dr. Carrier, Hon. Mem. ASME, inventor of the centrifugal refrigeration machine recently celebrated the completion of the 2000th unit manufactured by the Carrier Corporation. The first unit was placed in service in 1924. In 1911 Dr. Carrier presented his classic paper on rational psychometric formulas before ASME. This paper is still recognized as the basic authority in air conditioning. For his pioneering contribution to air conditioning, Dr. Carrier received the ASME Medal in 1934 and has been honored by many universities and technical societies.)

1950 National Power Show to Exhibit Innovations

MANUFACTURERS of power-plant equipment and apparatus have drawn heavily on research and development for many innovations soon to be revealed at the 19th National Exposition of Power and Mechanical Engineering. The exposition will be held in Grand Central Palace, New York, N. Y., Nov. 27–Dec. 2, 1950, under the auspices of The American Society of Mechanical Engineers, concurrent with the ASME Annual Meeting.

On exhibit will be thousands of highly specialized components of big power plants, also hundreds of smaller units for individual power or process steam.

A new combination gas-and-oil burner will be shown by a manufacturer of rotary burners. It can be switched from one fuel to the other with great rapidity by a change of nozzles and flip of the switch.

The exposition will include many displays of mechanical appliances. One popular group includes variable-speed motor drives in one-quarter to three-quarter horsepower ratings for the light load applications and extreme speed variations needed in many industrial installations. A manufacturer of variable-speed transmissions now offers a fractional-horsepower-motor drive unit, which is made with a selection of seven different change-speed ratios. Still another manufacturer, specializing in timers and controls, will exhibit an assembly for automatically operating a complete process from the entrance of raw material to the exit of finished product.

Jobs in Private Industry Favored

GOVERNMENT service is not attractive to engineering students in four universities in a Washington, D. C., area.

In a recent survey, 614 junior and senior engineering students at Catholic, George Washington, and Howard Universities and the University of Maryland, voted six to one in favor of jobs in private industry.

Their reasons were: (1) Quicker advancement in private industry; (2) regimentation and lack of individual incentive in government jobs; (3) low government salaries; (4) little opportunity for training in government; (5) opposition to government in business, and (6) general dislike of government work, civil service, red tape, and politics.

Louisiana Broadening Registration Law

THE Louisiana engineering registration law, which previously covered civil engineers only, has been amended to bring agricultural, chemical, electrical, mechanical, metallurgical, mining, and petroleum engineering within the scope of the law, according to the Legislature Bulletin of the National Society of Professional Engineers.

The expanded law contains the usual re-

quirements for registration regarding education and experience and contains a one-year grandfather clause for all branches, except civil. The effective date of the amendments was July 26, 1950. The State Registration Board has also been reorganized to reflect the new coverage and now consists of seven engineers.

More Management Courses at Stevens

BECAUSE it was found that the majority of engineering graduates tend to go into the fields of production and sales engineering, the Graduate School of Stevens Institute of Technology, Hoboken, N. J., opened this fall a department of management offering 34 courses in varied aspects of management. The new department offers specialization in business management and in the functioning of the free-enterprise system for engineering students to equip them to assume managerial responsibilities or to enter their own businesses.

The department is supervised by Prof. Arthur Lesser, Jr. Courses offered include production management, sales engineering, business management, human relations in production, industrial production in the American economy and others.

Instrumentation Office in NBS Established

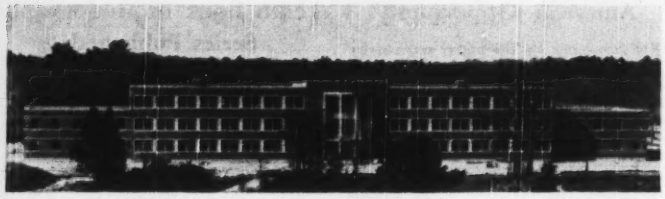
AN OFFICE of Basic Instrumentation was established by the National Bureau of Standards, Washington, D. C., on June 1, 1950. The new office co-ordinates a program of evaluation and improvement of instruments for measuring basic physical quantities.

The concept of the office was developed jointly by the National Bureau of Standards, the Office of Naval Research, the Office of Air Research, and the Atomic Energy Commission. The program, an extension and enlargement of a project that has been conducted in cooperation with the Office of Naval Research, will make the Bureau a more effective center for research and information on basic instrumentation.

Anti-Air-Pollution Group Reorganizes

THE 43-year old Smoke Prevention Association of America was reorganized by its members at a convention held in Montreal, Quebec, Can., May 25, 1950, under the new name, Air Pollution and Smoke Prevention Association of America, Inc. The Association is a voluntary, co-operative, nonprofit organization without capital stock, incorporated under the laws of the State of Illinois.

The purpose as stated in a facts sheet distributed by the Association is "to foster control of atmospheric pollution and improve air sanitation" by providing special services to workers in the field, such as standards, research projects, and smoke inspectors' conferences.



ALBERT KINGSBURY HALL, NEW HOME OF THE COLLEGE OF TECHNOLOGY OF THE UNIVERSITY OF NEW HAMPSHIRE, DURHAM, N. H.

(The new building honors the memory of Albert Kingsbury, honorary member ASME, who distinguished himself as the inventor and manufacturer of the Kingsbury pivoted thrust bearing. Dr. Kingsbury taught mechanical engineering at the University of New Hampshire and the Worcester Polytechnic Institute, Worcester, Mass. In 1910 he became a consulting engineer and devoted his time to the development of his invention. In 1918 he founded the Kingsbury Machine Works to manufacture the thrust bearing which became widely known and used. Dr. Kingsbury died in 1943.)

Four grades of membership are provided: Individual, company, sustaining, and honorary members, with annual dues ranging from $10 to $250.

Hamnett P. Munger, in charge of air pollution research at Battelle Memorial Institute, is serving as temporary executive secretary.

Officers for 1950–1951 are as follows: *President*, Charles W. Gruber, chief smoke inspector, Cincinnati, Ohio; *past-president*, Louis J. Cudbird, chief engineer, Property Department, Toronto, Ontario, Can.; *vice-presidents*, John T. Doyle, vice-president in charge of engineering, Thermix Corp., Greenwich, Conn.; Henry F. Hebley, Mem. ASME, research consultant, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa.; John L. Hodges, Mem. ASME, chief, Division of Air-Pollution Control, Philadelphia, Pa.; A. A. Raymond, Mem. ASME, superintendent, fuel and locomotive performance, New York Central Systems, Buffalo, N. Y.; and W. L. Stewart, Jr., executive vice-president, Union Oil Company, Los Angeles, Calif.

New Committee to Oversee Interests of Engineers in Civil Service

SIX prominent engineers were recently appointed by the U. S. Civil Service Commission to serve on an Advisory Committee on Engineering to aid the Commission in such matters pertaining to engineering personnel in Federal service as position classification standards, recruitment qualifications, and promotion policies.

Members of the new committee are: James D. Forrester, chairman, Department of Mining Engineering, Missouri School of Mines and Metallurgy, Rollo, Mo.; Edwin O. Griffenhagen, consulting engineer, Griffenhagen & Associates, Chicago, Ill.; Blake R. Van Leer, Mem. ASME, president, Georgia Institute of Technology, Atlanta, Ga.; Leslie N. McClellan, chief electrical engineer, Custom House, Denver, Colo.; Ezra B. Whitman, Mem. ASME, consulting engineer, Baltimore, Md.; and Joseph H. Ehlers, consulting engineer, Washington, D. C.

The engineers were recommended by the Engineers Joint Council, whose Committee on Engineers in Civil Service has been working with the Commission to protect the professional status of engineers in Federal service and to make Federal careers more attractive to professional men.

The objectives of the new committee as stated by Harry B. Mitchell, chairman of the Commission, are as follows:

1 To recommend to the Classification Division and to the Examining and Placement Division changes in practices, policies, or procedures which it is believed will place the recruitment, placement, and development of engineering personnel on a sounder basis;

2 To explore with the Commission implications of major changes in the field of personnel administration, as they affect professional engineers and related types of personnel;

3 To advise the Commission on programs and plans designed to improve Federal personnel administration of engineering personnel through a better understanding on the part of officials, employees, and citizens of the problems and purposes of the Federal government's merit system;

4 To advise the Commission's two divisions previously mentioned in the determination of policies and programs for filling adequately key engineering positions, and with the problems of bringing into and keeping in the Federal service the type of engineers which it must have if its work is to be performed efficiently;

5 To assist the two divisions in their efforts to develop programs designed to improve the competence of administrative and supervisory personnel dealings with engineers and associated employees; and

6 To provide the Commission with objective appraisals as to the effectiveness of the operations of the two divisions in so far as they affect the recruitment, placement, promotion, retention, and development of engineering personnel in the Federal service.

Technical Libraries Serve Profession

WHILE engineering societies are the principal agencies through which scientific information finds its way into print, yet it is through the engineering libraries that this information is passed on to the ultimate user. This point was made recently by Ralph H. Phelps, director, Engineering Societies Library, New York, N. Y., before the National Convention of the Special Libraries Association.

Mr. Phelps reported that "approximately 80 per cent of all scientific literature is obtained from libraries as against some 20 per cent from all other sources combined." One of the effects of the broadened scope of engineering societies, he said, was the specialized nature of many of the engineering publications.

Two factors have made it essential that libraries make their publications easily available: (1) Because of the high cost of publication, many engineering societies are restricting the number of papers given to members; and (2) because of the inability of most engineers to foresee future needs, few papers are purchased when they are placed on sale by the engineering societies.

Mr. Phelps suggested that engineering societies should consult libraries when considering changes in publication plans, so that its publications are produced in a manner which, without cost to the Societies, can be readily indexed, handled, and preserved. He suggested also that the Societies offer libraries a subscription plan so that for a single annual payment, a library could obtain all the publications of a society.

Coming Meetings

Metals and Welding

THE 32nd National Metals Congress and Exposition will be held in the International Amphitheatre, Chicago, Ill., Oct. 23–27, 1950. The Congress is sponsored by the American Society for Metals, American Welding Society, Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, and the Society for Non-Destructive Testing.

The exposition in which some 350 manufacturers will participate will cover new products and services in the field of production, treatment, and fabrication of metals.

In connection with the Congress the ASM and the AWS are holding annual meetings with technical sessions scheduled throughout the week. The AIME Institute of Metals and the Society for Non-Destructive Testing are scheduling three and two-day technical programs, respectively.

The ASM technical program will cover such subjects as surface phenomena, physical metallurgy, high-temperature metallurgy, heat-treatment, and fracture and plasticity.

The AWS program will consist of three symposiums and 70 technical papers devoted to the various aspects of welding, with emphasis on problems in industries having military significance and new research contributions to welding processes.

The Society for Non-Destructive Testing will present 10 technical papers and three symposiums on such subjects as fluoroscopic inspection on light metal alloy castings, magnetic particle inspection of welded pipe and tubing, and use of betratron for nondestructive testing.

Metal Casting

THE third annual Metals Casting Conference sponsored by Purdue University and the Michigan and Central Indiana chapters of the American Foundrymen's Society will be held in the Memorial Union building at Purdue University, Nov. 2–3, 1950. The conference will take up such subjects as recent engineering developments in the foundry industry, good casting design, current status of the Foundry Educational Foundation, fluid flow, gating and risering, and others. An exhibit of foundry products will be a feature of the conference.

AAAS

THE 1950 Annual Meeting of the American Association for the Advancement of Science will be held in Cleveland, Ohio, Dec. 26–30, 1950. More than 40 participating societies and organizations have scheduled more than 200 sessions.

Section M, Engineering, has planned eight sessions. These will consist of the following: (1) A joint program with the Cleveland Section of The American Society of Mechanical Engineers on Dec. 26; (2) a joint program with the Cleveland Engineering Society, Dec. 27; (3) a joint program with the Case Institute of Technology, Dec. 28; and (4) a three-session symposium on "Partnership of Industry and Science in Research" jointly sponsored by the Illinois Institute of Technology, Armour Research Institute, Mellon Institute of Industrial Research, and the Battelle Memorial Institute.

A feature of the meeting will be a series of tours to museums, laboratories, and industrial plants in the Cleveland area.

A science exposition will be held in the arena of Cleveland's public auditorium. Some 150 exhibits, almost twice as many as at last year's meeting, will be on display.

Meetings of Other Societies

Oct. 11–13
American Society of Civil Engineers, fall meeting, Congress Hotel, Chicago, Ill.

Oct. 13–14
American Society of Tool Engineers, semi-annual meeting, Detroit, Mich.

Oct. 16–20
National Safety Council, 38th national safety congress and exposition, Stevens Hotel, Chicago, Ill.

Oct. 23–25
American Gear Manufacturers Association, semi-annual meeting, Edgewater Beach Hotel, Chicago, Ill.

Oct. 23–27
American Society for Metals, national metal congress and exposition, Palmer House, Chicago, Ill.

Oct. 23–27
American Institute of Electrical Engineers, fall general meeting, Skirvin Hotel, Oklahoma City, Okla.

Nov. 2–3
Industrial Management Society, 14th annual national time, motion, and management clinic, Sheraton Hotel, Chicago, Ill.

Nov. 9–10
Society of Automotive Engineers, Inc., national meeting, The Mayo Hotel, Tulsa, Okla.

Nov. 14–17
American Society for Testing Materials, national meeting, Cincinnati, Ohio

(For ASME Calendar of Coming Events see page 854)

Engineering Literature

Research

A SELECTED and annotated bibliography of literature in the field of management of industrial research has been published by Arthur D. Little, Inc., Cambridge, Mass., and is being offered free to engineers interested in the subject.

The booklet contains two interesting charts, which show the growth in number of industrial research laboratories in the United States from approximately 300 in 1920 to 2500 in 1950, and the increase in expenditure for industrial research from less than $0,000,000 in 1920 to 450,000,000 in 1950.

The 13-page booklet contains 96 references classified under organization, control, research program, research laboratory, and miscellaneous.

Solder-Joint Fittings

THE American standard for Cast-Brass Solder-Joint Fittings (ASA B16.18–1950) for use with copper tubing in water service has been published by The American Society of Mechanical Engineers. The standard covers information on pressure ratings, abbreviations for end connections, sizes, and method of designating openings of reducing fittings, marking, minimum requirements for material, dimensions and tolerances and tests. The 17-page standard contains 11 tables of dimensions and tolerances covering the various kinds of fittings in use. Price is 75 cents.

Wrought Steels

INFORMATION on the strength of wrought steels at elevated temperatures has been reviewed and presented graphically in a report "The Strength of Wrought Steels at Elevated Temperatures," by R. F. Miller and J. J. Heger of the Carnegie-Illinois Steel Corporation. The report was published by the American Society for Testing Materials under the auspices of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals as special technical publication No. 100.

The report covers tensile, creep, and rupture properties of the standard commercial grades, together with the sources from which the data were obtained. The report is divided into two sections, the first on plain carbon and alloy steels containing molybdenum and up to 3 per cent chromium; the second on ferritic and austenitic steels containing more than 5 per cent chromium.

Copies may be obtained from ASME Order Department, 29 West 39th Street, New York, N. Y. Price $3; to ASTM and ASME members $2.25.

Quality Control

A 10-DAY course in Quality Control by Statistical Methods will be offered by the State University of Iowa, Iowa City, Iowa, Oct. 31–Nov. 10, 1950. The course is intended for supervisory personnel who can apply immediately the knowledge gained. The course has been offered seven times to representatives of industry from 28 states. Course fee including books and supplies is $100. For further information write to Prof. Lloyd A. Knowler, Department of Mathematics, State University of Iowa, Iowa City, Iowa.

Gears

THE American Standard Fine-Pitch Straight Bevel Gears (ASA B6.8-1950) was recently published by The American Society of Mechanical Engineers. The standard is identical in technical content with the standard on Fine-Pitch Straight Bevel Gears (AGMA 206.03) of the American Gear Manufacturers Association. The standard covers generated straight bevel gears of 20 diametral pitch and finer, for all shaft angles and with the number of teeth equal to or greater than 16/16, 15/17, 14/20, 13/30 for 90-deg shaft angle. Price per copy $1. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y.

Involute Serrations

THE American Standard Involute Serrations (ASA B5.26-1950) was recently published by The American Society of Mechanical Engineers. The new standard uses the text of the Serrated Shaft Standard of the Society of Automotive Engineers which was recently revised.

Involute serrations are multiple keys in the general form of internal and external gear teeth, as used for permanent fits between shafts and parts mounted on them. The purpose of the standard is to provide a uniform, easily fabricated set of serrations that can be made by several manufacturing processes.

This standard contains 18 tables and many illustrations. Price per copy is $1.00.

Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y.

Single-Point Tools

THE American Standard on Single-Point Tools and Tool Posts (ASA B5.22-1950) was recently published by The American Society of Mechanical Engineers.

The new standard replaces the following two standards: American Standard Terminology and Definitions for Single-Point Cutting Tools (ASA B5.13-1939), and American Standard Tool Shanks and Tool Posts (ASA B5.2-1943). It also includes three new sections covering standard types of single-point tools, sizes of carbide tips and sizes of tipped single-point tools. Price per copy is $1.25.

Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y.

1950 ASME Mechanical Catalog and Directory

THE fortieth annual ASME Mechanical Catalog and Directory, 1951 edition, was being distributed to ASME members when we went to press.

To build this book new each year requires months of work. Suppliers of mechanical equipment must be canvassed for descriptions of equipment, new and old. They are approached too for lists of products for the directory, new and old. Headings are under scrutiny at all times and by suggestions from members and by developments in industry, revisions in phraseology are incorporated to make the volume more serviceable.

New freshly cast type is used each year to make for ease in reading. Proofs are carefully checked by many people to provide for accuracy.

In this way members are supplied, each year, with a completely new book with products, names, and addresses all up-to-date.

According to the editors of the volume, it is the only book which covers the field of mechanical engineering so thoroughly.

A 20-page insert describing all ASME publications is included in this volume for the ready reference of ASME members. This insert describes all books, periodicals, codes, and standards available through the publications sales department.

People

E. J. Kates Elected ASME Fellow

EDGAR J. KATES, consulting engineer and Diesel engine specialist, was recently elected to the grade of Fellow ASME. He was born in New York, N. Y., Aug. 1, 1889, and educated at Columbia University.

Mr. Kates has been closely associated with the development of the Diesel engine and its application to public utilities. As chief engineer of the De LaVergne Machine Company, pioneer in the development of Diesels and now a part of the Baldwin Locomotive Works, Mr. Kates was responsible for technical features of some of the early Diesel engines.

In 1926 he entered the consultant field and shortly after was engaged in the design of the first automatic Diesel-electric plant. During World War II he designed several large Diesel power plants for the U. S. Naval Base in the Panama Canal Zone. He is the author of "Diesel-Electric Plants" and many technical articles.

E. J. KATES, NEW FELLOW ASME

Mr. Kates has been active in the ASME Oil and Gas Power Division which he helped to reorganize. He is a member of the Division's Oil Engine Power Costs study group and of the ASME Power Test Code Committee on Internal-Combustion Engines. From 1945 to 1949 he was a Director at Large of the Society and is currently serving as assistant treasurer.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

E. A. DEZUBAY, Jun. ASME, and G. W. HARDIGG, Westinghouse engineers, were awarded Benjamin Garver Lamme scholarships by the Westinghouse Electric Corporation. The scholarships honor Benjamin Garver Lamme, former chief engineer of the company.

HAROLD S. FALK, Mem. ASME, president, Falk Corporation of Milwaukee, Wis., was awarded the Industrial Relations Achievement Award of the National Metal Trades Association.

DUGALD CALEB JACKSON, Fellow and Hon. Mem. ASME, for 27 years head of the electrical-engineering department at Massachusetts Institute of Technology, Cambridge, Mass., was honored recently by a dedication of the Dugald Caleb Jackson Room at M.I.T. The room will be used for graduate seminars, honors groups, conferences, and other meetings of the electrical-engineering department.

J. O. ROSS and W. G. TURNO, both members of ASME, were among the eight leaders in the field of heating, ventilating, and air conditioning elected to life membership in the American Society of Heating and Ventilating Engineers.

ASME NEWS

Record Attendance Foreseen at ASME 1950 Annual Meeting

Hotel Statler, New York, N. Y., Nov. 26–Dec. 1

IF, as Carlyle says, a true university is a collection of books, then the 1950 Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Statler, New York, N. Y., Nov. 26–Dec. 1, 1950, can also be considered a kind of university for it deals in the stuff that books are made of—new ideas, new knowledge, new applications in a field of engineering so broad that it includes virtually all of engineering—civil, mining, electrical, and chemical, as well as mechanical.

The magnitude of the Annual Meeting alone with its 83 sessions and more than 200 papers conjures up the idea of a university. For the purpose of the meeting is not to discuss one aspect of mechanical engineering such as power, or machine design, or management. The meeting accepts within its ken three major props of a technological civilization, the development of power, the design of machines, and the management of men for the exploitation of both.

But just as in a university, there is more to an Annual Meeting than knowledge. Perhaps its most cherished gift is the fellowships that spring up at luncheon tables and in those moments between technical sessions when members gather in corridors. There are more like-minded engineers per square foot of an Annual Meeting hotel than at any other spot on the earth. Many a lifelong friendship between men residing in distant cities has had its beginning at an ASME Annual Meeting.

How to Prepare for the Meeting

If one half of the members who reside within commuting distance of New York took part in the meeting, 1950 attendance could break previous records. An attendance of 8000–9000 is not a fantastic goal. It can be achieved in 1950 if each member gives consideration to the following suggestions:

1 Read carefully the tentative program which follows: Draw a circle around every paper whose subject matter falls within your bread-and-butter interest.

2 Discuss the program with your immediate superior and tell him why the company will benefit by your presence at those particular sessions.

3 If the staff is large, suggest that the various sessions be assigned to different men so that not too many will be away at the same time.

4 In October start building a "kitty" by giving up desserts to cover cost of a few of the Annual Meeting luncheons.

5 Cross out the week of Nov. 26 on your wife's calendar and tell her that on specific evenings of that week you will not be available for Christmas-season floor washing or curtain hanging.

Charles Phelps Cushing

DOWNTOWN MANHATTAN FROM GOVERNORS ISLAND LIKE A CITY BUILT ON A HILL

Registration Fees for Nonmembers

A registration fee of $5 will be charged nonmembers attending the 1950 Annual Meeting of The American Society of Mechanical Engineers. The fee for student nonmembers will be $1.

The following nonmembers will be exempt from the payment of the registration fee.

- Immediate family of a member (any grade)
- Authors listed in the program or their appointed representatives
- Invited discussers
- Session chairmen and vice-chairmen
- Committeemen required to attend a meeting of their committee
- Session aides
- Members of the ASME Woman's Auxiliary
- Members of the Engineering Institute of Canada
- Members of societies listed in the program
- Distinguished guests invited by the President or Secretary

6 Discuss the program with nonmembers and point out sessions of special interest to them.

How to Enjoy the Meeting

On Broadway it is possible to enjoy a play without a program, but to learn something about the play and players is to enrich the enjoyment of the performance. At the Annual Meeting, too, it helps to know what is going on and how to get the most out of events. A few suggestions follow:

1 Always register. By doing so you place your name on a list of those present. Some old friend may want to look you up. The registration list is his best means for doing so.

2 Plan your day carefully. Once you decide on a session, go to the publication desk and buy the preprinted papers you plan to hear. Read them in advance of the session so you will know, generally, what will be discussed. It is a good idea to pick up papers for the following day also.

3 Introduce yourself to persons you do not know. You will miss plenty if you fail to learn something about the man that sits next to you at a particular session. He is likely to be a man in your industry concerned with the same problems as you are. He may have the answers you seek. But you will never know him unless you make the first move, tell him who you are, and launch into a discussion of some professional matter.

4 Attend luncheons and dinners: Unless you sit down with your fellows and eat at a common table, you will never really learn to know them. If you miss the luncheons, you will miss the real spirit of comradeship which is so much a part of an Annual Meeting. Take advantage of the opportunity to lunch with men you do not know. Avoid sitting with your office group. There are new engineering minds from distant parts of the country to exchange views with.

Before you leave the table, be sure to know as much as you can about the man to your right and left.

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 27, 1950, at 5:00 p.m. in the Hotel Statler, New York, N. Y., as a part of the Annual Meeting of the Society.

Members are urged to attend.

The 1950 Annual Meeting High Lights

THE program of the 1950 Annual Meeting planned by the ASME professional divisions and other program-making agencies is its own best argument why members of the Society should make every effort to attend. A glimpse through the following sessions will convince even the busiest engineer that such features as the Roy V. Wright lecture; the symposiums, panel discussions, and research papers which are available to all who want to hear an amazing fund of new facts and information accumulated throughout the year at great expense to individuals and organizations; the prominent leaders who will address luncheons and dinners; the Power Show which this year more than ever before becomes a part of the Annual Meeting; the plant trips; the college reunions; and the opportunity for meeting old friends—all these features should convince any engineer who prides himself as being a professional man that he can not afford to be absent.

Technical Sessions

When it comes to the technical program, the Annual Meeting offers so much wealth of information about new researches, applications, and operations on current developments within the engineering profession that one can virtually say with justification that a member who names what he wants, can find it among the offerings listed in the pages that follow. It may take careful reading but it is there among the 83 sessions and more than 200 papers.

Of special interest are the symposiums and panel discussions at which authorities will exchange views on specific problems. For example, the Railroad Division will take up the development of special freight cars designed for protection of lading. On the question of how effective has been the use of double-screen locomotive fuels, a symposium is planned which will include members of the Fuels as well as the Railroad Division. Another panel will take up the problem of attack on metals at high and low temperature and the fouling of tube banks encountered when burning heavy fuel oil.

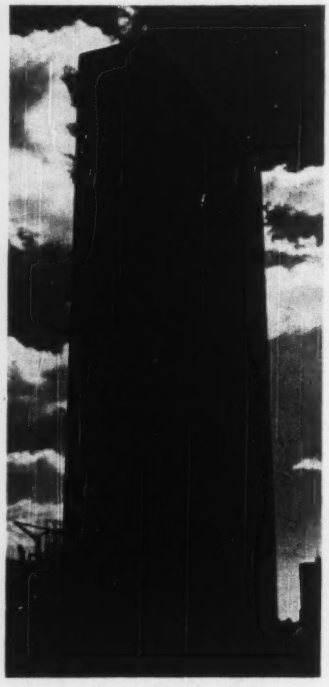
The Management Division in a series of papers will survey the entire small-plant-management field with emphasis on economics, techniques, and the new engineering problems which decentralization of big business and the growth of small producing units has introduced. In the field of education another symposium will explore what is wrong with the way fuels and fuels utilization are taught in the schools and in industry.

The Rubber and Plastics Division in a symposium on rubber and plastic gaskets and packing will discuss latest developments in this field.

Some of the technical sessions are sure to be events of historical significance. For example, on Thursday afternoon, Lester M. Goldsmith, chief engineer, Atlantic Refining Company, Philadelphia, Pa., will report on the first application in marine engineering of 1020 F steam.

Luncheons and Dinners

The program offers eleven opportunities for members to join their colleagues for a good meal. Under the general theme of the meeting, "The Engineer and His Civic Responsibility," prominent speakers have been invited to discuss various aspects of this theme at luncheon and dinner programs. At the President's Luncheon on Monday, A. W. Robertson, board chairman, Westinghouse Electric Corporation, Pittsburgh, Pa., will discuss "The Individual and Free Enterprise." At the Gas Turbine Power Luncheon on Wednesday, members will have an opportunity to hear George V. Denny, Jr., moderator, American Town Meeting of the Air, New York, N. Y., speak on "Public Events and Public Opinion." In another part of the hotel W. R. Woolrich, dean of engineering, University of Texas, Austin, Texas, during the Tuesday luncheon period, will be discussing aspects of the industrial economy of Britain at the IIRD luncheon.



Charles Phelps Cushing

UNITED NATIONS SECRETARIAT BUILDING THE FIRST SKYSCRAPER TO RISE ON THE MANHATTAN SITE OF THE UNITED NATIONS

At the Management luncheon on Wednesday, D. B. Mitchell, president, Sylvania Electric Products Inc., New York, N. Y., will explain his company's reasons for carrying on its business in small-plant units. Luncheons are also planned by the Power and Fuels Divisions.

The Hydraulics Division will hold its Old Timers dinner on Tuesday. This is an event that should not be missed by men working in hydraulics. The climax of the social program will be the banquet on Wednesday when the ASME honors members who have distinguished themselves in their profession. On Thursday the American Rocket Society, which is affiliated with the ASME, will hold its own Annual Dinner at which ARS awards will be conferred.

Members who wish to take their luncheons elsewhere may still enjoy the luncheon programs. Arrangements will be made at all luncheons and dinners to have extra chairs available so that when the luncheon has been served and the doors are opened, members may come into the room and listen to the remainder of the program in comfort.

National Power Show

Because the ASME has taken the National Power Show under its auspices, the 1950 Annual Meeting should provide a double experience to members. The theoretical and developmental ideas which will be talked about at the Hotel Statler will be dramatized by the exhibit of the newest products of the engineering art assembled for convenient inspection at Grand Central Palace, situated in the same general neighborhood of the city. Just as an exchange of ideas stimulates the thinking of an engineer working on some problem, so do exhibits arranged together suggest solutions to specific problems which might otherwise elude the search for them. The Show opens Monday at 2 p.m. and will be open every day of the meeting from 11 a.m. to 10 p.m. except on Wednesday, the night of the Annual Dinner. And on Saturday, the day following the meeting, the hours will be from 11 a.m. to 6 p.m.

The Wright Memorial Lecture

The Annual Meeting theme will also be developed during the Roy V. Wright Memorial Lecture which will be held at 5 p.m., Tuesday, Nov. 28. The Lecture honors the memory of Mr. Wright, who as chairman of the Engineers' Civic Responsibility Committee, did so much to awaken engineers to the need of assuming political responsibility.

American Rocket Society

The American Rocket Society which is affiliated with the ASME is planning a technical program of three sessions on rocket theory, development, operations, and testing on Thursday and Friday of the Annual Meeting. Twelve papers will be presented. At its 1950 Annual Dinner on Thursday, the ARS will confer awards on men who have distinguished themselves in the rocket field.

Plant Trips

New York is not only a thriving commercial metropolis but also an industrial center of the first magnitude. Because of the drama of its waterways and commerce and the glamor of its arts, New York City often takes its industries for granted. For those who want to inspect the production facilities of a truly great city, the Metropolitan Section is arranging a program of plant-inspection trips to some of the typical establishments in the metropolitan area. On the program will be a visit to the New York City Subway System power plant, elevated division of the Westinghouse Electric Corporation, Lionel Corporation, and several others. More specific information about the plant program will appear in the November issue.

College Reunions

With so many engineers expected in New York during the Annual Meeting, 19 engineering schools are planning to hold reunions during the week of the meeting. A list of schools and the addresses of college representatives who have charge of details and reservations for the reunions will be published in the November issue.

Women's Program

The ASME Woman's Auxiliary of the Metropolitan Section has arranged an interesting program for wives of members and guests at the Annual Meeting. On Monday they will attend the President's Luncheon and a tea dance. Tuesday will be devoted to a trip to the United Nations at Lake Success, L. I. After the Annual Business Meeting of the Woman's Auxiliary on Wednesday, a luncheon and a style show is scheduled at the Waldorf-Astoria Hotel. In the evening there will be the annual banquet. On Thursday an illustrated lecture by Emily B. Hunter of F. Schumacher and Company on "The Changing Scene in Decoration" is planned. The lecture will be preceded by a tour of the Williamsburgh Rooms of the Republican Club and followed by a luncheon.

The Tentative Program

MONDAY, NOVEMBER 27

8:00 a.m.

Registration

9:30 a.m.

Applied Mechanics (I)

Flow of Fluids and Plastic Materials

Velocity Distribution and Design Data for Ideal Incompressible Flow Through Cascades of Airfoils, by *Robert Resnick* and *L. J. Green.* (50—A-31)†

Approximate Solutions of Compressible Flows Past Bodies of Revolution by Variational Method, by *Chi-Teh Wang,* associate professor, New York University, New York, N. Y., and *Socrates de los Santos,* professor of aeronautical engineering, New York University, New York, N. Y. (50—A-33)

On the Extrusion of a Very Viscous Liquid, by *Herschel Weil,* General Electric Company, Schenectady, N. Y. (50—A-8)

Pressure Distribution in the Calendering of Plastic Materials, by *J. T. Bergen* and *G. W. Stott, Jr.,* Armstrong Cork Company, Lancaster, Pa. (50—A-34)

9:30 a.m.

Heat Transfer (I)

Heat Transfer in Rocket Motors and the Application of Film and Sweat Cooling, by *Robert H. Boden,* supervisor of combustion and propulsion activities, University of Michigan Aeronautical Research Center, Willow Run Airport, Ypsilanti, Mich. (50—A-53)

Intermittent Heating for Aircraft Ice Protection, With Application to Propellers and Jet Engines, by *Myron Tribus,* assistant professor, engineering department, University of California, Los Angeles, Calif. (50—A-55)

The Calculation of Heat Transfer in Solids With Temperature-Dependent Properties, by *Robert Plunkett,* assistant professor of mechanical engineering, Rice Institute, Houston, Texas. (50—A-54)

A Study of the Mechanism of Boiling Heat Transfer, by *Warren M. Rohsenow,* assistant professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., and *John A. Clark,* research assistant, Massachusetts Institute of Technology, Cambridge, Mass. (50—A-60)

9:30 a.m.

Hydraulic (I)—Gas Turbine Power (I)

The Possibility of Balanced Flow in Compressor and Turbine Blading, by *R. W. Pinnes,* research engineer, Bureau of Aeronautics, Washington, D. C.

Influence of Reynolds Number on Performance of Turbomachinery, by *A. M. G. Moody* and *Hunt Davis,* Elliott Company, Jeannette, Pa., and *M. D. Kotas,* National Advisory Committee for Aeronautics, Cleveland, Ohio.

9:30 a.m.

IIRD (I)—Fluid Meters (I)

Pressure-Temperature Relations in Gas-Filled (Class III) Thermometers, by *E. E. Modes,* development engineer, J. P. Marsh Corporation, Skokie, Ill. (50—A-48)

Precision and Accuracy of Orifice-Meter Installations, by *L. V. Cunningham,* mechanical engineer, Esso Standard Oil Company, Louisiana Division, Baton Rouge, La. (50—A-21)

Pitot-Venturi Flow Element, by *Henry W. Stoll,* mechanical engineer, Taylor Instrument Companies, Rochester, N. Y. (50—A-46)

9:30 a.m.

Production Engineering (I)

A Study of Float Requirements for Progressive-Line Continuous Manufacturing, by *Maurice Klee,* transmission division, electromotive division, General Motors Corporation, LaGrange, Ill.

Producing 65,000 Pistons Per Day, Using Automation With Quality Control, by *W. R. Slattery,* plant layout production office, Ford Motor Company, Detroit, Mich.

12:15 p.m.

President's Luncheon

Presiding: Retiring President *James D. Cunningham,* Fellow ASME.

Introduction: *A. C. Monteith,* vice president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa.

Speaker: *A. W. Robertson,* board chairman, Westinghouse Electric Corporation, Pittsburgh, Pa.

Subject: **The Individual and Free Enterprise.**

2:30 p.m.

Applied Mechanics (II)

Plastic Flow and Wave Propagation

Shake-Down in Continuous Media, by *P. S. Symonds,* assistant professor of engineering, Brown University, Providence, R. I. (by title) (50—A-17)

Evaluation of Stress Distribution in the Symmetrical Neck of Flat Tensile Bars, by *Julius Aronofsky,* research engineer, Magnolia Petroleum Company, Dallas, Texas. (50—A-14)

The Propagation of Longitudinal Waves of Plastic Deformation in a Bar of Material Exhibiting a Strain-Rate Effect, by *L. E. Malvern,* assistant professor of mathematics, Carnegie Institute of Technology, Pittsburgh, Pa. (50—A-18)

Plastic Wave Propagation Effects in High-Speed Testing, by *E. H. Lee,* associate professor of applied mathematics, and *H. Wolf,* research associate, Brown University, Providence, R. I. (50—A-35)

2:30 p.m.

Gas Turbine Power (II)—Aviation (I)

High-Speed Aerodynamic Problems of Turbojet Installations, by *Harold Luskin* and *Harold Klein,* Douglas Aircraft Company, Santa Monica, Calif.

Design of Turbojet Engines for Supersonic Speeds, by *Arnold Redding,* Westinghouse AGT Division.

Turbojet Design for High-Speed Flight, by *W. V. Hurley,* section engineer, performance section, air design division, General Electric Company.

2:30 p.m.

Heat Transfer (II)

Radiant Gas Burners, by *J. D. Keller,* consulting engineer, Pittsburgh, Pa. (50—A-59)

Emittance of Oxidized Metals, by *John P. Dobbins,* research engineer, North American Aviation, Inc., Los Angeles, Calif. (50—A-58)

Radiant Interchange Configuration Factors, by *D. C. Hamilton,* assistant professor, and *W. L. Sibbitt,* associate professor, mechanical-engineering, heat-transfer and thermodynamics department, Purdue University; and *G. A. Hawkins,* professor of thermodynamics, Westinghouse research professor of heat transfer, Purdue University, Lafayette, Ind.

2:30 p.m.

Hydraulic (II)

Measured Performance of Pump Impellers, by *W. C. Osborne,* research engineer, Hydrodynamics Laboratory, and *D. A. Morelli,* California Institute of Technology, Pasadena, Calif.

A Method for Calculating the Degree of Flow Deviation at the Discharge of Centrifugal-Pump Impellers, by *W. C. Osborne,* research engineer, hydrodynamics laboratory, California Institute of Technology, Pasadena, Calif.

Evaluation of the Quality of a Pump Impeller, by *D. A. Morelli* and *J. H. Beveridge,* California Institute of Technology, Pasadena, Calif.

2:30 p.m.

Management (I)

New Tasks for American Management

Predetermined Elemental Motion Times—A Step Forward in Work Standardization, by *Kendall C. White,* department of industrial and engineering administration, Cornell University, Ithaca, N. Y.

Practical Aspects of Methods-Time Measurement Application, by *William Hodson,* Methods Engineering Council, Pittsburgh, Pa.

2:30 p.m.

Production Engineering (II)

Factors Affecting Production on Single Automatic Screw Machine, by *W. E. Rollins,* screw-machine department, Brown & Sharpe Manufacturing Company, Providence, R. I.

Profitable Application of Automatics to Small-Lot Production, by *Myron Curtis,* director of engineering, The Warner & Swasey Company, Cleveland, Ohio.

† Preprint number. Use these numbers to order advance copies from ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price is 25 cents to members, 50 cents to nonmembers.

The Problems of Carbide High-Velocity Turning, by *Lee M. Davis*, assistant chief engineer, Jones & Lamson Machine Company, Springfield, Vt.

2:30 p.m.

Fluid Meters (II)–IIRD (II)

Study of Linear Resistance Flowmeters, by *F. W. Fleming*, Jackson, Miss., and *R. C. Binder*, professor of mechanical engineering, Purdue University, Lafayette, Ind. (50—A-37)

Orifice Meters With Supercritical Compressible Flow, by *R. G. Cunningham*, research engineer, Pure Oil Company, Chicago, Ill. (50—A-45)

Discharge Coefficients of Small-Diameter Orifices and Flow Nozzles, by *H. P. Grace* and *C. E. Lapple*, engineering department, engineering research laboratory, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. (50—A-64)

5:00 p.m.

Business Meeting

5:00 p.m.

Tea Dance

7:45 p.m.

Oil and Gas Power

Centrifugally Cast Bronze-Back Bearings for Heavy-Duty Operation, by *L. M. Tichvinsky*, professor of mechanical engineering, University of California, Berkeley, Calif.

An Instantaneous and Continuous Sodium-Lime Reversal Pyrometer, by *M. M. El Wakil*, graduate student, University of Wisconsin, Madison, Wis.; *P. S. Myers*, professor, University of Wisconsin; and *O. A. Uyehara*, professor, University of Wisconsin, Madison, Wis.

High-Pressure Compression-Ignition Engine-Turbine Cycles, by *R. A. Harmon*, International Harvester Company, Chicago, Ill., and *W. P. Green*, Illinois Institute of Technology, Chicago, Ill.

8:00 p.m.

Junior (I)

A Plan for the First Five Years After Graduation

Community Relations, by *Karl B. McEachron, Jr.*, Manager, Technical Division, General Electric Company, Schenectady, N. Y.

Part-Time Graduate Studies, by *J. C. McKeon*, Manager, University Relations, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Nontechnical Reading, by *W. B. Embler*, professor of English and head, Department of Humanities, Cooper Union School of Engineering, New York, N. Y.

Registration, by *H. L. Solberg*.

8:00 p.m.

Management (II)

Significance of the General Motors-United Automobile Worker's Five-Year Contract, by *Harry Anderson*, vice-president, General Motors Corporation, Detroit, Mich.

Employee Communications Through SKF Development Program, by *Harry Gracey*, training director, SKF Industries, Inc., Philadelphia, Pa.

8:00 p.m.

Steam-Jet Compressors—Fluid Meters (III)

Effect of Molecular Weight of Entrained Fluid on the Performance of Steam-Jet Ejectors, by *William C. Holton*, research engineer, Battelle Memorial Institute, Columbus, Ohio.

Effect of Temperature of Entrained Fluid on the Performance of Steam-Jet Ejectors, by *William C. Holton*, research engineer, and *E. V. Schultz* laboratory technician, Battelle Memorial Institute, Columbus, Ohio.

Measurement of Flow Rate in Saturated-Air Tests for Steam-Jet Ejectors, by *R. C. Binder*, professor of mechanical engineering, Purdue University, Lafayette, Ind. (50—A-47)

TUESDAY, NOVEMBER 28

9:30 a.m.

Applied Mechanics (III)

Vibrations

On Elastic Continua With Hereditary Characteristics, by *Enrico Volterra*, associate professor of mechanics, Illinois Institute of Technology, Chicago, Ill. (50—A-32)

Free Vibrations of a Pin-Ended Column With Constant Distance Between Pin Ends, by *David Burgreen*, research associate, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (50—A-9)

Vibration of Rectangular and Skew Cantilever Plates, by *M. V. Barton*, research engineer, University of Texas, Austin, Texas. (50—A-12)

The Transverse Vibrations of a Free Mass-Loaded Circular Plate, by *Robert E. Roberson*, head, analysis section, applied mathematics branch, mechanics division, Naval Research Laboratory, Washington, D. C. (50—A-24)

9:30 a.m.

Gas Turbine Power (III)

Aerodynamic Design Problems of Compressor Blading by *R. E. McNair* and *M. J. Brunner*, Westinghouse Electric Corporation, Lester, Pa.

Flow of a Compressible Fluid Through an Axial-Flow Compressor and a Mixed-Flow Impeller, by *Chung-Hua Wu*, Aeronautical research scientist, National Advisory Committee for Aeronautics, Cleveland, Ohio.

9:30 a.m.

Heat Transfer (III)

Heat and Momentum Transfer Through Steam in Plain and Modified Annuli, by *George W. Govier* and *Robert R. White*, University of Michigan, Ann Arbor, Mich.

Heat Transfer to a Fluid Flowing Turbulently in a Smooth Pipe With Walls at Constant Temperature, by *R. A. Seban*, University of California, Berkeley, Calif., and *T. Shimasaki*.

The Precise Measurement of Temperature as an Aid to the Study of Heat Transfer, by *H. Dean Baker*, associate professor, Columbia University, New York, N. Y., consultant, Pratt & Whitney Aircraft Division, and *E. A. Ryder*, consulting engineer, Pratt & Whitney Aircraft Division, United Aircraft Corp., Hartford, Conn.

Theory of the Oil Cooler; Heat Exchange and Pressure Drop in Slots With Parallel Walls at Variable Viscosities, by *H. Schuh* (50—A-56)

9:30 a.m.

Hydraulic (III)

An Investigation of Flow Through Screens, by *W. D. Baines* and *E. G. Peterson*, Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Ia. (50—A-23)

Index Testing of Hydraulic Turbines, by *Grant H. Vosden*, assistant chief engineer, S. Morgan Smith Company, York, Pa. (50—A-52)

9:30 a.m.

IIRD (III)

Nondimensional Study of Proportional-Plus-Reset Control of a Single Capacity System, by *John A. Hrones* and *James B. Reswick*, mechanical-engineering department, Massachusetts Institute of Technology, Cambridge, Mass. (50—A-42)

Controller Settings for Optimum Control, by *W. A. Wolfe*, associate professor of mechanical engineering, University of British Columbia, Vancouver, Canada. (50—A-22)

An Improved Pneumatic-Control System, by *R. E. Clarridge*, manager of application engineering department, Taylor Instrument Companies, Rochester, N. Y.

9:30 a.m.

Management (III)—Production Engineering (III)

Standards Give Assurance, by *J. G. Vincent*, executive vice-president, Packard Motor Company, Detroit, Mich.

Standards Aid Quality Control, by *Howard Coonley*, chairman, executive committee, American Standards Association, New York, N. Y.

***Panel*: Visual Aids for Management Education,** by *Ellis Ott*, Rutgers University, New Brunswick, N. J., and *Paul C. Clifford*, Montclair Teachers' College, Montclair, N. J.

9:30 a.m.

Railroad (I)—Materials Handling (I)

Symposium: Development of Special Freight Cars Designed for Protection Lading

Design Features of the General American-Evans "Damage Free" Box Car, by *R. M. Lamport*, assistant vice-president, General American Transportation Corporation, Chicago, Ill.

Special Loading Cars in Automotive-Parts Service, by *F. W. Bess*, general car and loading inspector, Chesapeake and Ohio Railway Company, Grand Rapids, Mich.

12:15 p.m.

Power Luncheon

Presiding: *Glenn B. Warren*, manager, turbine-engineering divisions, General Electric Company, Schenectady, N. Y.

12:15 p.m.

Wood Industries Luncheon

12:15 p.m.

IIRD Luncheon

Presiding: *H. L. Mason*, chairman, IIRD; research professor of mechanical engineering, Iowa State College, Ames, Ia.
Speaker: *W. R. Woolrich*, dean of engineering, University of Texas, Austin, Texas.
Subject: **Industrial Economy of Britain.**

12:15 p.m.

Heat Transfer Luncheon

2:30 p.m.

Applied Mechanics (IV)

Buckling Problems

Sinusoidal Torsional Buckling of Bars of Angle Section Under Bending Loads, as a Problem of Plate Theory, by *Harold J. Plass, Jr.*, research assistant in engineering mechanics, Stauford University, Palo Alto, Calif. (50—A-15)

Buckling of a Sandwich Cylinder Under Uniform Axial-Compression Load, by *A. Cemal Eringen*, research assistant professor of mechanics, Illinois Institute of Technology, Chicago, Ill. (50—A-3)

Straight and Curved Beam Columns With Arbitrary Distribution of Loading and Stiffness, by *C. M. Tyler, Jr.*, assistant professor of mechanical engineering, Carnegie Institute of Technology, Pittsburgh, Pa., and *J. G. Christiano*, Carnegie Institute of Technology, Pittsburgh, Pa. (50—A-11)

The Stability of Plates Reinforced by Longitudinal Ribs, by *J. M. Klitchieff*, faculty of technology, Belgrade, Yugoslavia (by title). (50—A-10)

2:30 p.m.

Aviation (II)—Materials Handling (II)—SAE—IAS

Military Requirements for Air Transport, by *Col. L. S. Rochie*, U. S. Air Force, Wright Field, Dayton, Ohio.

Review of Military Cargo Transportation, by *J. R. McGowen*, project engineer, and *S. S. Kreisler*, Douglas Aircraft Company, Santa Monica, Calif.

2:30 p.m.

Gas Turbine Power (IV)—Heat Transfer (IV)

The Liquid-Coupled Indirect-Transfer Regenerator, by *W. M. Kays* and *A. L. London*, professor, mechanical engineering, Stanford University, Stanford University, Calif.

Optimum Design of Gas-Turbine Regenerators, by *Warren M. Rohsenow, T. R. Yoas*, and *J. F. Brady*, Massachusetts Institute of Technology, Cambridge, Mass.

2:30 p.m.

Hydraulic (IV)

Round-Table Discussion on Cavitation
Moderator: *R. T. Knapp*.

2:30 p.m.

Management (IV)

Productive Standards in Advertising, by *E. C. Barnes*, editor, *Harvard Business Review*, Soldiers Field, Boston, Mass.

Productivity Standards—Sales, by *Noble Hall*, chief sales industrial engineer, Atlantic Refining Company, Philadelphia, Pa.

Productivity Standards—Warehousing, by *S. Stokes Tomlin, Jr.*, distribution engineer, marketing, Shell Oil Company, New York, N. Y.

2:30 p.m.

Railroad (II)—Fuels (I)

Symposium on Performance Experience With Double-Screened Locomotive Fuel

Speakers:
John S. Swan, fuel-conservation engineer, Louisville and Nashville Railroad, Louisville, Ky.

Earl C. Payne, consulting engineer, Pittsburgh Consolidated Coal Company, Pittsburgh, Pa.

H. G. Pike, superintendent of equipment, Pittsburgh and Lake Erie Railroad, McKees Rocks, Pa.

W. O. Cottingham, superintendent of locomotive performance, Western Maryland Railway Company, Hagerstown, Md.

Experimental Locomotive With Cinder-Collection and Ash-Disposal System, by *Elmer J. Boer*, assistant supervisor; *John M. Allen*, research engineer; and *Bertrand A. Landry*, supervisor, Battelle Memorial Institute, Columbus, Ohio.

2:30 p.m.

Wood Industries (I)

Coated Abrasive for Wood (author to be announced).

Carbides for Woodworking Applications, by *R. D. Brooks*, Firth Sterling Steel and Carbide Corporation, McKeesport, Pa.

Development and Use of the 8-Tooth Circular Saw, by *W. C. Moser*, vice-president, Gamble Brothers, Louisville, Ky.

5:00 p.m.

Roy V. Wright Lecture

6:00 p.m.

Applied Mechanics Dinner

6:00 p.m.

Hydraulic Old Timers Dinner

Presiding: *Irl C. Martin*, president, Woodward Governor Company, Rockford, Ill.

8:00 p.m.

Aviation (III)—Materials Handling (III)—SAE—IAS

What's New in Cargo Terminals, by *George E. Hagemann*, technical editor, Ronald Press, New York, N. Y.

Overhead Tow and Floor Tow for Cargo Operations, by *Jervis C. Webb*, treasurer and general manager, Jervis B. Webb Company, Detroit, Mich.

Aircraft for Military Cargo Operations, by *Alan F. Kelsey*, project engineer, Boeing Airplane Company, Seattle, Wash.

8:00 p.m.

Fuels (II)—Power (I)—Effect of Temperature (I)

Panel: **Problems Encountered in Burning Heavy Fuel Oil as Related to Attack of Metals at High and Low Temperature and the Fouling of Tube Banks**

Speakers:
O. L. Wood, Jr., construction-engineering division, General Electric Company, Schenectady, N. Y.,
E. F. Tibbetts, metallurgical engineer, The Lummus Company, New York, N. Y.
V. P. Estcourt, engineer of steam generation, Pacific Gas and Electric Company, San Francisco, Calif.,
Dwight Douglass, superintendent of power, The Hartford Electric Light Company, Hartford, Conn.

8:00 p.m.

Properties of Gases and Gas Mixtures

A Summary of Viscosity and Heat-Conduction Data for He, A, H_2, O_2, N_2, CO, CO_2, H_2O and Air, by *F. G. Keyes*, professor of physical chemistry, Massachusetts Institute of Technology, Cambridge, Mass. (50—A-40)

Measurements of the Heat-Conductivity of Nitrogen-Carbon Dioxide Mixtures, by *F. G. Keyes*, professor of physical chemistry, Massachusetts Institute of Technology, Cambridge, Mass. (50—A-38)

8:00 p.m.

Fluid Meters (III)

A Study of Head Loss in Venturi Meter-Diffuser Sections, by *Joel Warren*, assistant professor of mechanical engineering, Brown University, Providence, R. I.

Discharge Measurements by Means of Venturi Tubes, by *Andre L. Jorissen*, professor of civil engineering, The Pennsylvania State College, State College, Pa.

8:00 p.m.

Wood Industries (II)

Special Methods for Drying Wood, by *H. Tombach.*

Analytical Studies in Suppression of Wood Fires, by *George J. Tauze*, University of California, Los Angeles, Calif.

Development of Forest-Fire Suppression Equipment, by *Gilbert Stewart*, State of Michigan.

8:00 p.m.

Metal Cutting Data—Cutting Fluids (I)—Production Engineering (IV)

Basic Factors in the Hot-Machining of Metals, by *E. J. Krabacher*, research engineer, and *M. E. Merchant*, senior research physicist, Cincinnati Milling Machine Company, Cincinnati, Ohio.

Cutting Temperatures and Metal-Cutting Phenomena, by *B. T. Chao*, research assistant, department of mechanical engineering, and *K. J. Trigger*, professor of mechanical engineering, University of Illinois, Urbana, Ill. (50—A-43)

Chip Pressure Versus Cutting Speed When Machining Cast Iron With Light and Medium Cuts, by *K. V. Olsen*, Royal Technical University, Copenhagen, Denmark.

WEDNESDAY, NOVEMBER 29

9:30 a.m.

Applied Mechanics (V)

Plate Theory

Some Thin-Plate Problems by the Sine Transform, by *L. I. Deserall*, instructor, University of Utah; and *C. J. Thorne*, associate professor of mathematics, University of Utah, Salt Lake City, Utah. (50—A-13)

Axially Symmetrical Plates With Linearly Varying Thickness, by *H. D. Conway*, professor of mechanics, Cornell University, Ithaca, N. Y. (50—A-6)

Large Deflection Theory for Plates With Small Initial Curvature Loaded in Edge Compression, by *John M. Coan*, associate professor of aeronautical engineering, University of Illinois, Urbana, Ill. (50—A-2)

The Limit Design of Space Frames, by *Jacques Heyman*, research associate in graduate division of applied mathematics, Brown University, Providence, R. I. (50—A-4)

9:30 a.m.

Gas Turbine Power (V)—Fuels (III)

Pressure and Residence Time Effects on Combustion of Pulverized Coal, by *W. E. Young.*

Technical and Commercial Aspects of the Application of Residual Oil as Fuel for Gas Turbines and High-Temperature Boilers, by *C. F. Kottcamp* and *L. O. Crockett*, Gulf Oil Corporation, Pittsburgh, Pa.

9:30 a.m.

Machine Design (I)

Some Design Aspects of Metal-Powder Parts, by *D. C. Bradley*, market development division, New Jersey Zinc Company, New York, N. Y. (50—A-27)

The Fields of Utility of Investment Casting, by *Rawson L. Wood*, president, and *D. Von Ludwig*, Arwood Precision Casting Corporation, Brooklyn, N. Y. (50—A-28)

9:30 a.m.

Management (V)—Education (I)—Junior (II)

Planning Your Future, by *T. A. Marshall, Jr.*, senior procedure analyst, management research co-ordinating division, Metropolitan Life Insurance Company, New York, N. Y.

What Industry Expects of and the Opportunities It Offers the Young Engineer in Our System of Free Enterprise, by *Thomas C. Gary*, special assistant to the chief engineer, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del.

9:30 a.m.

Cutting Fluids (II)—Lubrication (I)—Production Engineering (V)

Grinding Fluids, Characteristics and Applications, by *H. W. Wagner*, research engineer, research laboratories mechanical section, Norton Company, Worcester, Mass. (50—A-44)

The Application of Cutting Fluids to Machining by *E. Strieder*, assistant sales manager, Cincinnati Milling Products Division, and *R. B. Niebusch*, manager, shop tools, Cincinnati Milling Machine Company, Cincinnati, Ohio.

9:30 a.m.

Railroad (III)

Progress in Railway Mechanical Engineering-Report of Committee RR-6 Survey, by *R. M. Coultas*, transportation divisions, General Electric Company, Schenectady, N. Y.

Progress Report on the Alco-GE Gas-Turbine Electric Locomotive, by *A. H. Morey*, locomotive engineering division, General Electric Company, Erie, Pa.

Development of the Aluminum Tank Car, by *G. B. Hauser*, chief railroad-development engineer, Aluminum Corporation of America, New Kensington, Pa.

9:30 a.m.

Power (II)

Power-Plant Operation With Hot Lime-Zeolite Process, by *Louis F. Wirth*, National Aluminate Corporation, Chicago, Ill., and *William S. Butler*, Dow Chemical Company, Ludington, Mich.

Basic Study for a Generating Station, by *G. R. Milne*, mechanical engineer, Consolidated Edison Company of New York, Inc., New York, N. Y.

Fireside Deposits of Steam Generators Minimized Through Humidification of Combustion Air, by *Paul Murphy, Jr.*, boiler-room engineer; *John D. Piper*, chemical supervisor, research laboratory; and *C. R. Schmausky*, superintendent, Delray Plant, The Detroit Edison Company, Detroit, Mich.

12:15 p.m.

Management Luncheon

Presiding: *H. B. Maynard*, president, Methods Engineering Council, Pittsburgh, Pa., and *Gideon M. Varga*, vice-president, S. G. Yulke Company, New York, N. Y., and lecturer, industrial engineering department, Columbia University, New York, N. Y.
Speaker: *D. B. Mitchell*, president, Sylvania Electric Products, Inc., New York, N. Y.
Subject: **Why Sylvania Operates in Small Plant Units.**

12:15 p.m.

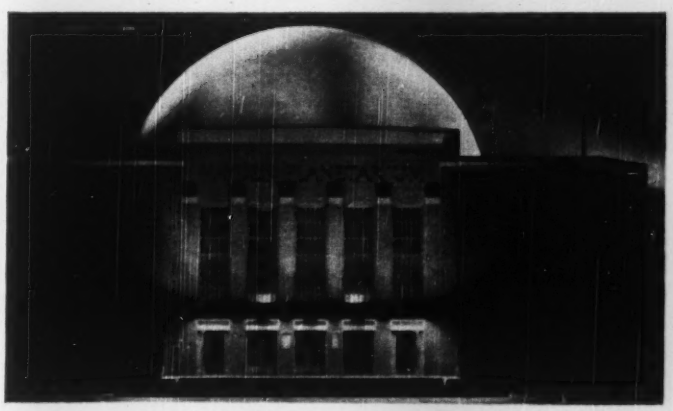
Gas Turbine Power—Aviation—Materials Handling—Institute of Aeronautical Sciences—Society of Automotive Engineers Luncheon

Presiding: *J. F. Elliott*, director of research, Locomotive Development Committee, Bituminous Coal Research, Baltimore, Md.
Toastmaster: *J. T. Rettaliata*, Illinois Institute of Technology, Chicago, Ill.
Speaker: *George V. Denny, Jr.*, moderator, Town Meeting of the Air, New York, N. Y.
Subject: **Public Events and Public Opinion.**

2:30 p.m.

Applied Mechanics (VI)

Elasticity Problems



HAYDEN PLANETARIUM JUST WEST OF CENTRAL PARK AT 81ST STREET IS ONE OF THE MANY POINTS OF INTEREST IN NEW YORK, N. Y.

Analysis of Deep Beams, by *H. D. Conway*, professor of mechanics, Cornell University, Ithaca, N. Y., *L. Chow* and *G. W. Morgan* (50—A-7)

A Fourier Integral Solution for the Plane-Stress Problem of a Circular Ring With Concentrated Radial Loads, by *Carl W. Nelson*, assistant professor of engineering design, University of California, Berkeley, Calif. (50—A-16)

The Torsion of Elastic Spheres in Contact, by *James L. Lubkin*, research engineer, Midwest Research Institute, Kansas City, Mo. (50—A-1)

A Note on Elastic Surface Deformation, by *Murray Kornhauser*, Navy Department, Bureau of Ships, Washington, D. C. (50—A-30)

2:30 p.m.

Education (II)

The Principles and Purpose of the ECPD, by *James W. Parker*, president, Detroit Edison Company, Detroit, Mich.

The Objectives and Policies Relating to Accrediting, by *S. C. Hollister*, dean, College of Engineering, Cornell University, Ithaca, N. Y.

2:30 p.m.

Gas Turbine Power (VI)—Fuels (IV)

Review of Combustion Phenomena for the Gas Turbine, by *D. G. Shepard*, Cornell University, Ithaca, N. Y.

Turbojet Combustor Efficiency at High Altitude, by *W. T. Olson, J. H. Childs*, and *E. R. Jonash*, National Advisory Committee for Aeronautics, Cleveland, Ohio.

2:30 p.m.

Machine Design (II)

Furnace Brazing of Machine Parts, by *H. M. Webber*, electric furnace and oven section, industrial heating divisions, General Electric Company, Schenectady, N. Y. (50—A-29)

Determination of the Dynamic Coefficient of Friction for Transient Conditions, by *G. G. Gould*, Naval Ordnance Laboratory, Silver Spring, Md. (50—A-61)

2:30 p.m.

Management (VI)

The Economic Problems of Small Plants, and Their Solutions, by *C. F. Hughitt*, chief, small business division, U. S. Department of Commerce, Washington, D. C.

Know-How Management for Small Plants, by *Adolf Ehbrecht*, vice-president, Grier Reproducer Corporation, New York, N. Y.

New Tasks in Engineering for Small Plants, by *F. W. Miller*, vice-president, Yarnall-Waring Company, Philadelphia, Pa.

Small-Plant Management Abroad, by *James D. Mooney*, chairman of the board, Technical Managers, Inc., New York, N. Y.

2:30 p.m.

Materials Handling (IV)

Material-Handling Equipment in the Railway Express Service, by *C. G. Peterson*, chief engineer, Railway Express Agency, New York, N. Y.

Mechanical Handling of Warehousing and Shipping—General Electric Refrigeration and Home Freezers, by *C. H. Pace, Jr.*, General Electric Company, Erie, Pa.

2:30 p.m.

Furnace Performance Factors—Fuels (V)—Power (III)—Heat Transfer (V)

Furnace Heat Absorption in Pulverized-Coal-Fired Steam Generator, Willow Island Station

Part I: Furnace-Heat Absorption Efficiency as Shown by Temperature and Composition of Gases Leaving the Furnace, by *James W. Myers*, fuel engineer, and *Richard C. Corey*, supervising engineer, combustion research section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

Part II: Variation in Heat Absorption as Shown by Measurement of Surface Temperature of Exposed Side of Furnace Tubes, by *F. G. Ely*, research engineer, and *N. H. Twyman*, test engineer, research and development department, Babcock & Wilcox Company, Alliance, Ohio.

6:30 p.m.

Banquet

THURSDAY, NOVEMBER 30

9:30 a.m.

Machine Design (III)

Machine Design as a Career, by *J. F. Downie Smith*, dean of engineering, Iowa State College, Ames, Iowa. (50—A-26)

Dynamic Loading of Chain Drives, by *William K. Stamets, Jr.*, consulting engineer, Hoge Building, Seattle, Wash. (50—A-25)

9:30 a.m.

Rubber and Plastics (I)

Advances in Revolving Shaft Seals, by *E. F. Riessing* and *H. B. Klein*, National Motor Bearing Company, Detroit, Mich.

Advances in the Uses of Rubber in Engineering 1940–1950, by *Miss L. E. Straka*, Goodyear Tire and Rubber Company, Akron, Ohio.

9:30 a.m.

Safety—Management (VII)

Safety as a Tool for Management, by *Daniel Farrell*, assistant director of industrial relations, Shell Pipe Line Corporation, Houston, Tex.

Management's Responsibility for Accident Prevention, by *George T. Jacoby*, assistant director of industrial relations, General Motors Corporation, Detroit, Mich.

A Survey of Savings Through Safety, by *John V. Grimaldi*, director, Industrial Engineering Division, Association of Casualty and Surety Companies, New York, N. Y.

9:30 a.m.

Boiler Feedwater Studies—Power (IV)

Simplified Process for Determining Steam Purity, by *S. T. Powell*, consulting chemical engineer, Baltimore, Md., and *I. G. McChesney*, assistant superintendent electrical operations and planning, Rochester Gas and Electric Corporation, Rochester, N. Y.

The Prevention of Embrittlement Cracking, by *A. A. Berk*, supervising chemist, boiler water research section, Bureau of Mines, College Park, Md.

The Solubility of Quartz and Some Other Substances in Superheated Steam at High Pressures, by *G. W. Morey*, physical chemist, and *J. M. Hesselgesser*, geophysical laboratory, Carnegie Institution of Washington, Washington, D. C.

9:30 a.m.

Fuels (VI)

Symposium on Fuel Engineering Education

What Engineering Schools Should Teach About Fuels and Fuel Utilization, by *A. A. Potter*, dean of engineering, Purdue University, Lafayette, Ind.

How Industry Can Co-Operate With and Assist Engineering and Technical Schools in Offering Instruction in Fuels and Fuel Utilization, by *W. E. Reaser*, chairman, division of engineering, Swarthmore College, Swarthmore, Pa.

What Is Being Done Today on Instruction in Fuel Utilization for Engineering Schools? by *C. C. Wright*, head, division of fuel technology, School of Mineral Industries, Pennsylvania State College, State College, Pa.

On-the-Job Training Programs and Fuel Utilization, by *R. J. Brandon*, fuel engineer, production department, The Detroit Edison Company, Detroit, Mich.

9:30 a.m.

Heat Transfer (VI)—Applied Mechanics (VII)

Strain Hardening and Softening With Time in Reference to Creep and Relaxation, by *A. Nadai*, Westinghouse Electric Corp., East Pittsburgh, Pa.

Relaxation of Stress in a Heat-Exchanger Tube of Ideal Material, by *E. A. Davis*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Expanded Tube Joints in Feedwater Heaters and Heat Exchangers, by *F. F. Fisher* and *G. F. Brown*, Detroit Edison Company, Detroit, Mich.

Analysis of Stresses and Displacements in Heat-Exchanger Expansion Joints, by *G. Murphy*, Iowa State College, Iowa City, Iowa.

9:30 a.m.

American Rocket Society (I)

Rocket Theory

A General Method for the Calculation of Theoretical Performance of Rocket Engines, by *V. N. Hugg*, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

Stability of Liquid Films for Cooling Rocket Motors, by *M. J. Zucrow*, professor of gas turbines and jet propulsion, and *C. M. Beighley* and *E. L. Knuth*, School of Mechanical Engineering, Purdue University, Lafayette, Ind.

Notes on the Behavior of Supersonic Gases in Overexpanded Nozzles, by *K. Schelier* and *J. A. Bierlein*, rocket development engineers, USAF Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio.

Optimum-Thrust Programming for a Sounding Rocket, by *H. S. Tsien*, Goddard professor, and *Robert C. Evans*, Guggenheim Jet-Propulsion Center, California Institute of Technology, Pasadena, Calif.

Heat Recovery and Maximum Thermodynamic Efficiency in a Rocket, by *J. J. Ward* and *J. W. Clegg*, Battelle Memorial Institute, Columbus, Ohio.

12:15 p.m.

Members and Students Luncheon

12:15 p.m.

Fuels Luncheon

Presiding: *Elmer R. Kaiser*, assistant director of research, Bituminous Coal Research, Inc., Columbus, Ohio.
Speaker: Dr. James Boyd, director, Bureau of Mines, Washington, D. C.
Subject: **Change in Patterns of Fuel Supply.**

2:30 p.m.

Rubber and Plastics (II)—Machine Design (IV)

Symposium

Sealing With Rubber—Relation of Design to Properties of Elastomers, by *J. W. Swarts*, Linear, Inc., Philadelphia, Pa.

Studies of Relaxation Characteristics of Nonmetallic Gasket Materials, by *R. G. Farnam*, F. D. Farnam Company, Chicago, Ill.

Rubber and Plastics in Packings, by *F. C. Thorn*, Garlock Packing Company, Palmyra, N. Y.

2:30 p.m.

Fuels (VII)

Combination Spreader Stoker and Waste-Fuel Furnaces, by *F. C. Messaros*, chief engineer, American Engineering Company, Philadelphia, Pa. (50—A-63)

Burning Petroleum Coke on Spreader Stokers (motion picture), by *Otto de Lorenzi*, director of education, Combustion Engineering-Superheater, Inc., New York, N. Y.

2:30 p.m.

Heat Transfer (VII)—Applied Mechanics (VIII)

Expansion Joints for Heat Exchangers, by *M. F. Sayre* and *S. Kopp*, Alco Products Division, American Locomotive Company, Dunkirk, N. Y. (Title to come) *C. L. Bulow*, Bridgeport Brass Company, Bridgeport, Conn.

Aluminum Alloys in Heat-Exchanger Construction, by *E. G. Kort* and *J. S. Hamilton*, Aluminum Company of America, New Kensington, Pa.

A Leak-Proof Heat Exchanger, by *J. T. Cullen*, General Electric Company, Schenectady, N. Y.

2:30 p.m.

Petroleum (I)

The Properties and Performance of Silicone Lubricants, by *G. Grant, 3rd*, and *C. C. Currie*, Dow Corning Corporation, Midland, Mich.

Some Industrial Experiences With Synthetic Lubricants, by *C. H. Sweatt* and *T. W. Langer*, Union Carbide and Carbon Corporation.

2:30 p.m.

American Rocket Society (II)

Rocket Operations

Operations With the High-Altitude Sounding Rocket Viking, by *J. P. Layton, G. L. Martin* Company, Baltimore, Md.

Rocket-Engine Flight Testing, by *R. F. Gomperts*, aeronautical rocket-propulsion engineer, power plant branch, Edwards Air Force Base, Muroc, Calif.

Naval Air Rocket Test Station—Purpose and Progress, by *Lt. Comdr F. C. Durant*, 3rd, USNR, Engineering Officer, U. S. Naval Air Rocket Test Station, Lake Denmark, Dover, N. J.

2:30 p.m.

Power (V)

Stress and Deflection Tests of Steam-Turbine Diaphragm, by *V. C. Taylor*, engineering technical department, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. (50—A-49)

Improving Ship Propulsion Gears by Tooth Shaving, by *H. W. Semar*, manager, marine engineering, Westinghouse Electric Corporation, Philadelphia, Pa.

The Engineering of a 30,500-ton Super Tanker—the First Ship Using One Thousand and Twenty-Degree F Steam, by *Lester M. Goldsmith*, chief engineer, Atlantic Refining Company and Philadelphia Tankers, Inc., Philadelphia, Pa.

2:30 p.m.

Materials Handling (V)

Methods of Handling Coal at Today's Power Plants, by *Frank Lovell*, Link Belt Co., Chicago, Ill.

Coal-Handling Installation at the Phillips Station, Wireton, Pa., by *E. M. Hays*, Dravo Corporation, Pittsburgh, Pa.

6:00 p.m.

American Rocket Society Dinner

8:00 p.m.

Fuels (VIII)

Analysis of Acoustical Oscillation in Burners, by *A. R. Putnam*, Battelle Memorial Institute, Columbus, Ohio.

Effect of High-Frequency Sound Waves on Air-Propane Flame, by *C. J. Kippenham*, Washington University, St. Louis, Mo., and *H. O. Croft*, dean of engineering, University of Missouri, Columbia, Mo.

8:00 p.m.

Petroleum (II)—Power (VI)

Recommended Practices for the Cleaning of Turbine Lubricating Systems After Service, prepared by Joint ASTM-ASME Committee on Turbine Lubrication.

The Maintenance and Servicing of Hydraulic Systems for Machine Tools, by *J. Howard Groom*, service department manager, Cincinnati Milling Machine Company, Cincinnati, Ohio.

8:00 p.m.

Effect of Temperature (II)

An Introduction to Arc-Cast Molybdenum and Its Alloys, by *John L. Ham*, metallurgist, Climax Molybdenum Company, Detroit, Mich.

Experience With Austenitic Steels in High-Temperature Service in the Petroleum Industry, by *M. E. Holmberg*, Phillips Petroleum Company, Bartlesville, Okla. (50—A-41)

An Investigation of the Role of Aluminum in the Graphitization of Plain Carbon Steel, by *A. M. Hall*, assistant supervisor, and *E. E. Fletcher*, research engineer, Battelle Memorial Institute, Columbus, Ohio.

Cast Nickel-Chromium Molybdenum Valve Steel Casting After 50,000 Hours Service at 900 F, by *T. N. Armstrong*, development and research division, The International Nickel Company, New York, N. Y., and *R. J. Greene*, research laboratory, The International Nickel Company, Bayonne, N. J.

Creep and Creep-Rupture Testing of Steam-Boiler Materials, by *J. B. Romer*, consultant, research and development division, The Babcock & Wilcox Company, Alliance Ohio, and *D. H. Newell*, chief metallurgist, The Babcock & Wilcox Tube Company, Beaver Falls, Pa.

The General Relaxation Properties of a Bolting Steel, by *Donald Frey*, professor, Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

8:00 p.m.

Lubrication (II)

Viscosity and Density of Lubricating Oils From 0 to 150,000 psig and 32 to 425 F, by *Donald Bradbury, Melvin Mark*, and *R. V. Kleinschmidt*, Division of Engineering Sciences, Harvard University, Cambridge, Mass.

FRIDAY, DECEMBER 1

9:30 a.m.

Rubber and Plastics (III)

Strength Behavior of Adhesive Bonds, by *H. P. Meissner*, Massachusetts Institute of Technology, Cambridge, Mass., and *Gunther H. Baldauf*, Ecusta Paper Corporation, Pisgah Forest, N. C. (50—A-20)

Creep Properties of Lucite and Plexiglas for Tension, Compression, Bending, and Torsion, by *Joseph Marin, Yoh-Han Pao*, and *George Cuff*, engineering experiment station, Pennsylvania State College, State College, Pa. (50—A-19)

Advances in Plastics, 1949–1950, by *H. M. Richardson*, DeBell & Richardson, Springfield, Mass.

9:30 a.m.

Petroleum (III)—Boiler Code Committee

Effects of Internal Pressure on Stresses and Strains in Bolted Flanged Connections, by *D. B. Wesstrom*, design engineer, and *S. E. Bergh*, design engineer, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. (50—A-51)

A Design Procedure for Integral Flanges With Tapered Hubs, by *W. F. Jaep*, process engineer, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. (50—A-50)

Formula for Pipe Thickness, by *W. J. Buston*, assistant staff engineer, and *W. R. Burrows*, assistant chief engineer, Whiting Refinery, Standard Oil Company (Indiana), Whiting, Indiana. (50—A-62)

9:30 a.m.

Process Industries (I)

The Manufacture of Small Ice, by *Crosby Field*, president, Flakice Corporation, Brooklyn, N. Y. (50—A-5)

Residential Heat Pumps—Their Operation and Performance, by *E. R. Ambrose*, air-conditioning engineer, American Gas and Electric Service Corporation, New York, N. Y.

9:30 a.m.

Metals Engineering (I)

Continuous Casting of Aluminum, Steel, Copper, and Magnesium.

9:30 a.m.

Lubrication (III)

Performance of Oil-Film Bearings With Abrasive-Containing Lubricants, by *Arvid E. Roach*, research engineer, Research Laboratories Division, General Motors Corporation, Detroit, Mich. (50—A-36)

The Effect of Oil Viscosity on the Power-Transmitting Capacity of Spur Gears, by *V. N. Borzoff, J. B. Accinelli*, and *A. G. Cattaneo*, Shell Development Company, Emeryville, Calif. (50—A-39)

9:30 a.m.

American Rocket Society (III)

Testing and Design

Micro-Scale Rocket Studies, by *Bradford Darling* and *Saul Wolf*, division of industry co-operation, Massachusetts Institute of Technology, Cambridge, Mass.

Some Measurements of the Burning Rates of Mixed Liquid Bi-Propellants, by *L. Greiner, H. Haussman, G. R. Makepeace*, and *C. W. Tait*, Naval Ordnance Test Station, Inyokern, Calif.

Microseconds Photographic Technique Applied to Injection Investigation and Problems of Ultra-High-Pressure Combustion, by *R. L. Wehrli*, senior physicist, Reaction Motors, Inc., Rockaway, N. J.

Design of Turbopumps for ATO Rockets, by *C. C. Ross*, chief engineer, liquid engine department, Aerojet Engineering Corporation, Azusa, Calif.

Throttling Thrust Chamber Control, by *M. Meyer*, supervising project engineer, rocket department, Curtiss-Wright Corporation, Propeller Division, Caldwell, N. J.

9:30 a.m.

Power (VII)

High-Temperature Properties and Characteristics of Ferritic Steam Piping, by *A. W. Rankin*, assistant division engineer, and *W. A. Reich*, General Electric Company, Schenectady, N. Y.

Report on Split Steam Lead at New Orleans, by *A. W. Rankin*, assistant division engineer, and *W. A. Reich*, General Electric Company, Schenectady, N. Y.

Intake Tunnel Design for Condenser Circulating Pumps, by *A. J. Ponomareff*, manager of condenser engineering, Westinghouse Electric Corporation, Lester, Pa.

9:30 a.m.

Textile (I)

Twister Ring Lubrication, by *L. C. Rotter*, Lincoln Engineering Company, St. Louis, Mo.

Fine Count Spinning of Rayon Yarn, by Frank Perutz, Snia Viscosa, Milan, Italy.

2:30 p.m.

Process Industries (II)

Some Examples of the Functional Use of Glass as a Coating for Steel, by *W. G. Martin*, manager, glass-coating materials division, A. O. Smith Corporation, Milwaukee, Wis. (50—A-57)

The Technology of Porcelain Enameling on Steel, by *Edward Marbaker*, senior fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

2:30 p.m.

Metals Engineering (II)

Engineering Properties of Titanium, Nodular Iron, and Cast or Malleable Iron.

2:30 p.m.

Fuels (IX)—Air Pollution—Power (VIII)

Background of Present Smoke-Regulation Ordinances, by *J. F. Barkley*, chief, Fuels Utilization Division, U. S. Bureau of Mines, Washington, D. C.

Present Status of Air-Pollution Control, by *H. P. Munger*, assistant supervisor in charge of air pollution control, Battelle Memorial Institute, Columbus, Ohio.

2:30 p.m.

Textile (II)

Instrumentation in the Textile Industry, by *Alex N. Engblom*, president, A. B. Dye-stuff Chemical Corporation, Gothenburg, Sweden.

Materials Handling in Textile Mills, by *Herbert L. Werner*, partner, Werner Textile Consultants, New York, N. Y.

13th AIME-ASME Joint Fuels Conference, Oct. 24–25

THE only ASME national technical event in October, and the last one before the 1950 Annual Meeting will be the 13th AIME-ASME Joint Fuels Conference to be held at the Statler Hotel, Cleveland, Ohio, Oct. 24–25, 1950. A technical program consisting of four sessions at which eight technical papers will be presented and discussed will cover such subjects as pulverized coal, gas analyzers for better combustion, national fuel situation, coal sampling, and others.

The social program consisting of two luncheons and a banquet will present an opportunity for men in the solid-fuels industry to hear authorities speak on such current national problems as air pollution, competitive aspects of the utility business, and the role of electric energy in war and peace.

For a detailed account of the technical program, see page 763 of the September issue.

The Joint Fuels Conference traditionally honors an individual who has distinguished himself in the field of solid fuels. This year the Conference will honor Julian E. Tobey, president, Appalachian Coals Inc., Cleveland, Ohio, by conferring on him the Percy Nicholls Award for 1950. As the guiding spirit of a comprehensive series of fuel-engineering conferences which he organized in most of the industrial centers of the United States, Mr. Tobey is credited with improving practices of coal burning and the application of coal-burning equipment.

The planning committee for the Conference has not neglected the interests of wives and guests of members. The women of the Cleveland Section, under the chairmanship of Mrs. William Stewart, have planned a program to run concurrently with the technical program which should make a visit to Cleveland a pleasant one for members of the ASME Woman's auxiliary. A feature of the program will be a talk on fashion trends by a staff member of one of Cleveland's finest stores.

New High-Temperature Data to Be Published

A COMPILATION of new high-temperature data on cast and wrought austenitic-chromium-nickel alloys is currently being undertaken by the Joint Committee on the

Effect of Temperature on the Properties of Metals sponsored by the ASTM and ASME.

The new compilation will replace the 1938 publication "Creep Data" published by the sponsoring societies. It will be the first in a series of projects planned by the Committee to meet the need for up-to-date data on various metals and alloys used at high temperature.

New data were requested by the ASME Boiler Code Committee, Prime Movers Committee of the Edison Electric Institute, the Committee on Power Generation of the Association of Edison Illuminating Companies, and the Air Force.

According to the Joint Committee's policy of "limited objectives," it is planned to divide the metals into several groups and to issue information on each group as soon as it is available, rather than to follow the 1938 plan of issuing a large book covering all metals.

The Joint Committee is inviting producers to support the Committee's project by contributing any original information they may have on the following chromium-nickel stainless steels: 18-8, 18-8 Ti, 18-8 Cb, 18-8 Mo, 18-8 Mo-Cb, 25-12, 25-20, 25-20 Si, 25-20 Cb, 15-35.

For convenience of those contributing information, form sheets have been sent to producers. The front side of the form is, in effect, a "short form" designed for properties and information which the producers have already derived from their creep and rupture tests. The reverse side is a "long form" and may be used to contribute more detailed creep and rupture data desired by some engineers. The Committee feels it is essential that the short form be completed and that while the long form may be optional, most producers would complete it also.

Additional forms may be obtained from H. C. Cross, Batelle Memorial Institute, Columbus, Ohio.

Nuclear Energy Program Announced

THE Nuclear Energy Division of the Metropolitan Section of The American Society of Mechanical Engineers will hold three meetings on the engineering applications of nuclear energy.

Attendance will be restricted to members of the Founder Societies.

The first meeting of the series will be on Oct. 31, 1950, at the Engineering Societies Building, New York, N. Y. John R. Menke of the Nuclear Development Associates, Inc., New York, N. Y., will speak.

For clearance, write to R. W. Cockrell, % The M. W. Kellogg Company, 225 Broadway, New York, N. Y.

Give name, business firm, full address, position or title, Founder Society, and grade of membership.

Junior Forum

Advice to Juniors Seeking New Jobs

SOME junior members after two or three years in industry become dissatisfied with their jobs and set out to find greater opportunity. In this search they often write letters to potential employers in which they underrate the value of their own engineering training and experience. F. V. Hartman, chairman, ASME St. Louis Section, received such a letter, and sensing the discouragement of the writer, undertook to analyze it and to advise the writer how it could be improved.

Mr. Hartman's reply to the young man who had applied to him for a job, follows. It may be helpful to other junior members:

"I am sorry that we have no opening now in our organization but I believe I may be able to offer you considerable help in the way of guidance.

Opportunities in Small Plants

"There are many opportunities for graduate engineers today, although it may require a bit more effort in some instances than was required two or three years ago. Most large companies are taking on men, and there also seems to be much opportunity in small industry. According to recent observations, there are thousands of small plants in this country that do not employ a single engineer. Most of these can use technical help and they offer good opportunities to the young man who can sell them on the fact that he has a sound training in fundamentals which will enable him to analyze problems and to work out situations for greater economy. You are one of these young men.

"I believe you have much more to offer today than you appreciate. In fact, I gather from your letter and information sheet that you are inclined to underrate yourself. It is true that you have much to learn when you enter an organization but with your training you can learn fast, and if you are alert, there is much in the way of new ideas which you can contribute from the beginning of your employment.

Do Not Belittle Present Job

"You state that you want a job which will utilize 'at least part' of your college training. It seems that as a machine operator you can use some of your training on your present job, if it's only to obtain a better understanding of machine operation and the viewpoint of the average machine operator, in order to make you a better mechanical engineer. You can also learn much in the way of machines, maintenance, materials handling, management, and labor relations. All of these obtained in your present position make excellent experience which you cannot learn in any college and which you can learn better and understand more fully with the college training you already have. So do not belittle your present job; build it up for what it's worth to you in the way of experience and observation. In a sense, you can explain it as an apprentice training which you are taking for your own benefit.

Arrange Your Own Record

"Some of my college friends may not fully agree, but I'm inclined to think you could profit by discarding their personnel information blank. While your record appears good, there are a number of blank spaces on it which may give an unfavorable impression. I suggest that you make your own form, leaving out the blank spaces which do not apply to your history, and concentrate on what you have. You might itemize most of the general information much as is done in the form but tell a little more about your practical experience and explain what you did and what you are learning in the way of building up your experience.

"Be sure to omit your remark about the leg which is weak when bent. You must be in good physical shape if you spent thirteen months in the Army Infantry, so I believe you can honestly omit mention of the leg and thus eliminate a 'strike' against yourself.

"So, remember your many assets and sell them! You have had some good practical experience and you have the fundamentals: Mathematics, mechanics, physics, and chemistry, and these with your training in one of our best engineering colleges will enable you to think analytically. Then I assume you have learned to write and to talk; both are essential in selling your ideas which may be necessary in report form or verbally, or both. And, most important, I assume that in your schooling and especially on your jobs, you have learned to get along with others. This is essential in any kind of employment. Don't hesitate to explain this in your application.

The Drawing-Board Job

"Now, in looking for your job, it is hoped that you now have some idea of the kind of work for which you are best suited. In your college work you evidently favored machine design. There is a need for creative designers today. If you still think you can do this and that you will like it, then make an effort to get a drawing-board job. Your schooling and experience are an excellent background for it. On the other hand, possibly your experience leads you to some other field of mechanical engineering or makes you yet uncertain. In that case, you need not feel discouraged. You have your fundamentals which will enable you to adapt yourself to almost any branch of mechanical engineering and you will soon find yourself.

"When you make application for employment, pick out a number of companies that you think you would like to work for, and in your application explain why. Maybe you know someone in the organization; or possibly you are impressed with the product and you think you would like to get into the organization for that reason. Such an approach generally helps to make the impression that you have something to offer and are not applying merely to be on the receiving end of the arrangement."

Twelve Regional Student-Branch Conferences Climax Eventful 1949–1950 Season

MORE than twenty-four hundred student members of The American Society of Mechanical Engineers, representing most of the 129 student branches of the Society, attended the twelve regional conferences held between April 7 and May 6, 1950, to mark the close of another eventful academic year. The conferences were held at centrally located schools with an eye to encouraging as many members in each region to attend as possible.

The prize papers were of a high caliber and the judges, time and again, had difficulty in making decisions. Some idea of the range of engineering interest among ASME student members may be had from a review of précis of nine of the 12 first-prize-winning papers which appear in the following pages.

The earnestness of the students and those in charge of the conferences accounts for the success which resulted, and explains the popularity of these annual events among student members of the Society. These local annual meetings reflect favorably what may be hoped for when these young men come up to play their part in the future life of the ASME.

The conference reflected the interest and enthusiasm of the students for their profession and presented an opportunity for new friendships, discussion of the merits of respective schools, football teams, and other matters close to the hearts of young men. Most important were their ideas of ways and means to promote a deeper interest in professional development and a more active interest in student participation in local student-branch activities.

Throughout the conference the big question was how to stimulate greater attendance at local meetings and participation by local members in the profession to serve as speakers; incidentally, to broaden the horizon and inform the student member about progress being made in the field of mechanical engineering. Many felt that illustrated talks were enjoying great popularity and one conference suggested more field trips.

The list of prize-winning papers and authors appears on the following page.

Rensselaer Is Host to Region I

Two hundred student members from 15 engineering schools attended the Region I conference held at Rensselaer Polytechnic Institute, Troy, N. Y. Frank Gunby, vice president, ASME Region I, presented prizes for the five winning papers. An innovation was the presentation of a "Man-Mile Trophy" which the RPI student branch donated to Region I branches to be annually awarded to that branch whose attendance at the conference represented the greatest number of man-miles. The trophy is to be retained by the winning branch for one year. The Northeastern University branch with a total of 6003 man-miles won the trophy for 1950.

The questions taken up at the conference were: (1) Best means of distributing news about branch activities; (2) value of a news-letter; (3) methods of scoring and judging papers; and (4) practice of soliciting money from ASME sections to help defray expenses incurred by the students attending the conferences. Several field trips were made to various industrial plants in or near Troy.

Region II at NYU

More than 100 students assembled at New York University to hear the prize papers and talks of interest. After strolling through the Hall of Fame, students visited the many laboratories on the campus. At the afternoon session the prizes were awarded and a talk on "The Value of the PE License to the Young Engineer" was given by George Nicastro, Mem. ASME, and Westinghouse Manufacturing Company presented "A Model Interview." A tea dance was held at the close of the day.

Region III Guest of Annapolis

Student branch conference, Region III, was held at the United States Naval Academy, Annapolis, Md. It was attended by 256 members. Here the questions of scoring the prize papers and the transfer of student members to the grade of junior were under discussion. An irregularity arose which led to the suggestion of having written instructions for procedure in properly carrying out the meetings of a regional conference. It was announced that the Woman's Auxiliary of the Philadelphia Section would award a $25 prize and suitable certificate to the student branch represented by the winning competitor. An inspection trip was conducted at U. S. Naval Engineering Experiment Station and the laboratories of the marine-engineering department, Isherwood Hall.

Region IV Met in Clemson, S. C.

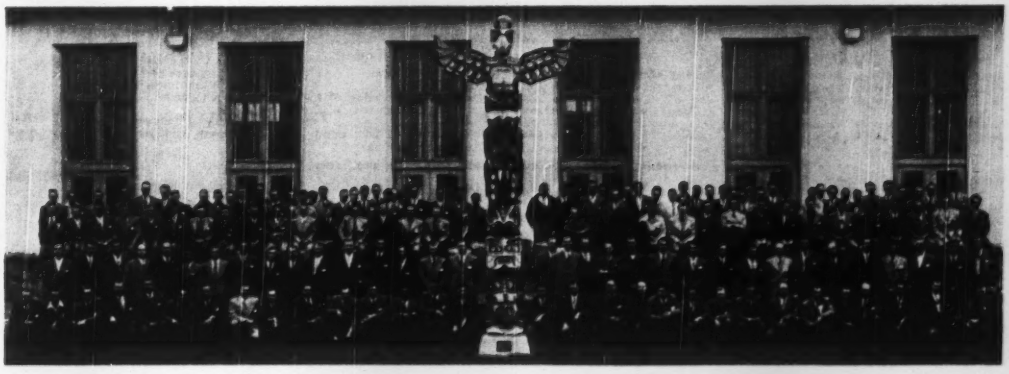
The technical meetings were well attended by the 204 student members from Region IV who met in Clemson, S. C. At the meeting it was suggested that more careful selection of student-branch officers be made and the term of office should be for the whole school year rather than for the quarter. Honorary chairmen were asked to stress student transfers to junior grade and to call attention to the Charles T. Main Award topic for 1950. More collaboration with the local sections by way of joint meetings or forums was also discussed. The visitors enjoyed inspection trips to the college heating plant and engineering laboratories and the Deering-Milliken Rayon and Woolen Mills.

Carnegie Tech Host to Region V

The Region V Conference was attended by 318 and was held at Carnegie Institute of Technology. James D. Cunningham, president, ASME, was the principal speaker at the luncheon. The University of Detroit again won the "man-miles" trophy. A plant-inspection trip to the Irvin Works, Carnegie Steel Corporation, was made by 77. Many took advantage of the opportunity to visit the campus at Carnegie and some went over to the University of Pittsburgh campus.

Region VI Holds Two Conferences

The Southern Tier met at the Brown Hotel,



REGION VII PACIFIC NORTHWEST STUDENT BRANCH CONFERENCE HELD AT UNIVERSITY OF BRITISH COLUMBIA, MAY 4-6, 1950

Louisville, Ky., for the 18th Annual Midwest Region VI, Southern Tier Student Conference. In attendance were 254. Among the many topics taken under consideration was the question of judges of student prize papers. It was the consensus that papers should be judged by experienced engineers who are ASME members. In preparing plans for the meeting next year a recommendation was made that, if possible, the regional vice-president of the Society should attend the conference. Inspection trips were made to the Paddy's Run Power Station, American Air Filter Company, Bluegrass Cooperage, and Louisville *Courier-Journal* Building; on the following afternoon the visitors were guests of the companies conducting the trip: Brown Forman Distillers Corporation, Joseph E. Seagram and Company, Colgate-Palmolive-Peet Company, and Henry Vogt Machine Company.

Schools in the Northern Tier were guests of South Dakota State College, Brookings, S. Dak., with 103 in attendance. The group talked at length about scoring sheets and judging prize papers. They toured the campus and inspected the laboratories. The welcoming address was made by Forrest Nagler, vice-president ASME, Region VI, at the opening session. In the evening at the banquet Mr. Nagler spoke on "Engineering Problems." Guests were invited to attend the dress-rehearsal performance of the operetta "Naughty Marietta."

Region VII Holds Two Conferences

Some 200 students journeyed to Vancouver, Canada, to attend the Region VII, Pacific Northwest Conference as guests of the University of British Columbia. Four technical sessions were held. Inspection trips were arranged to see the Imperial Cannery, British Columbia Sugar Refinery, Sumner Iron Works, Canadian White Pine Lumber Company, Canadian Western Lumber Company, and Vivian Diesel Works. A boat trip up Howe Sound was combined with an inspection trip to either the concentrator of the Britannia Mining and Smelting Company at Britannia Beach or to the sulphite pulp mill of the British Columbia Pulp and Paper Company at Woodfibre. The visitors were guests at two banquets and had the opportunity of hearing some interesting talks.

The Region VII Pacific Southwest Conference was held at the University of Santa Clara and 56 attended. Here also the judges had a difficult time selecting the winner. An interesting point was brought to light here regarding schools that give courses in thesis. It was evident that students who were required to take the course would have an added advantage. Other member schools had laboratory courses and speech courses which might apply to the talks indirectly, but these courses were not always required. Scoring of papers and discussions were subjects that received consideration. All who attended benefited by the experience and appreciated the hospitality extended.

Three Conferences in Region VIII

The Region VIII Southern Tier Conference was held at Southern Methodist University in conjunction with the Region VIII Regional Administrative Committee Meeting held in Dallas, Texas. Some 190 students participated. Ways of improving the student branches were given considerable consideration. It was agreed that the present setup of the Southern Tier was satisfactory. It was the opinion of the group that the membership pin was one of the important and tangible returns for membership in the Society and that the practice of giving pins should be restored.

C. E. Davies, secretary, ASME, spoke at the banquet and James D. Cunningham, president, ASME, spoke at a morning session.

The Region VIII, Northern Tier, conference was held at Kansas State College and 182 members took part in the program. They were welcomed by M. A. Durland, dean of the engineering school, and besides the prize papers an interesting talk was presented by C. H. Weiser, Southwestern Bell Telephone Company. The guest speaker at the banquet was Carl J. Eckhardt, vice-president, ASME Region VIII, who spoke on "The Human Side of Engineering."

The Region VIII Rocky Mountain Tier, Conference was held at New Mexico College of

1950 ASME Regional Student Conference Prize Winners

REGION I, NEW ENGLAND, RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y., APRIL 21, 22, 1950

Attendance: 209 — Papers Presented: 13

Prize	*Recipient*	*Title of Paper*	*College*
First	Philip C. Martin	Experimental Measurements and Analysis of the Torque Reaction of a Gas-Turbine Nozzle Row	Brown University
Second	Joel Ollendorf	A General Equation for Axially Loaded Columns	Rensselaer Polytechnic Institute
Third	Gero Madelung	Steam Power Catapult for Heavy Aircraft	Clarkson College of Technology
Fourth	Reinhold Seperack	The Conference Method in Product Development	Yale University
Old Guard	Robert E. Edminster	An Inexpensive Propeller-Driven Ice-Boat Design, Construction, and Operation.	University of Vermont

REGION II, EASTERN, NEW YORK UNIVERSITY, NEW YORK, N. Y., APRIL 22, 1950

Attendance: 131 — Papers Presented: 13

Prize	*Recipient*	*Title of Paper*	*College*
First	Joseph Engelberg	An Analysis of Transient Vibrations by Means of a Mechanical Analog	Cooper Union School of Engineering
Second	John J. Happell, Jr.	Heat-Transfer Design	Newark College of Engineering
Third	Warren Schmidt	Visual Aids for Descriptive Geometry	Pratt Institute
Fourth	Martin Kropnitsky	The Turbojet. A New Engine	Rutgers University
Old Guard	John Hoglund	Design for Low Quantity Production	Polytechnic Institute of Brooklyn, Evening School

REGION III, ALLEGHENIES, U. S. NAVAL ACADEMY MIDSHIPMAN SCHOOL, ANNAPOLIS, MD., APRIL 14, 15, 1950

Attendance: 256 — Papers Presented: 14

Prize	*Recipient*	*Title of Paper*	*College*
First	Phyllis H. Evans	Rocket Motors	Drexel Institute of Technology
Second	Harry B. Croswell	Allowances for Time Study in Industry	George Washington University
Third	Joseph B. Depman	The Effect of Spark-Plug Gap on Low Load Operation of Internal-Combustion Engines	Villanova College
Fourth	George R. Veazey	Designing a Racing-Model Airplane	University of Delaware
Old Guard	Willard C. MacFarland	Design of a Computer for Great Circle Course and Distance	U. S. Naval Academy Midshipman School

REGION IV, SOUTHERN, CLEMSON COLLEGE, CLEMSON COLLEGE, S. C., APRIL 7, 8, 1950

Attendance: 204 — Papers Presented: 13

Prize	*Recipient*	*Title of Paper*	*College*
First	Paul M. Kruemcke	The Fischer-Tropsch Process	University of South Carolina
Second	Leroy R. Boggs	A New Type of Viscosimeter	North Carolina State College
Third	Lincoln M. Young	Hydraulic Drives	University of Alabama
Fourth	James L. Hamilton, Jr.	Insight into the Outlook for the Coal Industry	Duke University
Old Guard	Hershel E. Lane	Heat Pump	Mississippi State College

REGION V, MIDWEST, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA., APRIL 24, 25, 26, 1950

Attendance: 318 — Papers Presented: 12

Prize	*Recipient*	*Title of Paper*	*College*
First	Raymond J. Slezak	An Approach to the Generation and Utilization of Direct Current	University of Akron
Second	Dwight Hayne	Value of Contacts	University of Detroit
Third	Roy E. Elicker	Molding-Sand Deformation	Michigan State College
Fourth	Sanford Brown	Determination of Heat-Transfer Coefficients From Tubes to Boiling Liquids	Case Institute of Technology
Old Guard	James Colebrook	Design and Construction of a Pressure-Gage Testing Machine for Cardiac Research	University of Cincinnati

REGION VI, SOUTHERN TIER, UNIVERSITY OF KENTUCKY, LOUISVILLE, KY., APRIL 20, 21, 1950.

Attendance: 254 Papers Presented: 9

Prize	Recipient	Title of Paper	College
First	Donald P. Reich	Principles and Applications of Hydraulic Pumps and Motors	Purdue University
Second	Warren K. Rogers	An Interpretation of a Pressure-Time Curve	State University of Iowa
Third	Lewis Wargo	The M.S.M. Iron-Lung Project	Missouri School of Mines
Tie for 4th and Old Guard	Wayne L. Loving	Spray Metallizing	Rose Polytechnic Institute
	William A. Nolan	Atomic Power	University of Louisville

REGION VI, NORTHERN TIER, SOUTH DAKOTA STATE COLLEGE, BROOKINGS, S. DAK., MAY 1, 2, 1950

Attendance: 103 Papers Presented: 11

Prize	Recipient	Title of Paper	College
First	Arthur Dewsberry	Diesels Underground	Northwestern University
Second	Leslie C. Hardison	Short-Term Wear Testing of Diesel Engines	Illinois Institute of Technology
Third	Leslie Matheson	Free-Piston Diesel as a Source of Power	North Dakota State College
Fourth	Blair L. Wildermuth	New Horizons in Plastics	Marquette University
Old Guard	John Cochrane	Notes and Comments on the History and Operation of Modern Marine Steam-Power Plants	University of Minnesota

REGION VII, PACIFIC SOUTHWEST, UNIVERSITY OF SANTA CLARA, SANTA CLARA, CALIF., APRIL 14, 15, 1950

Attendance: 56 Papers Presented: 14

Prize	Recipient	Title of Paper	College
First	John M. Simonsen	The Design of a Strain Meter	University of Utah
Second	Harry D. Dickinson	Heavy Boiler Fuel Oils as an Economical Source of Diesel Engine Fuel	University of Southern California
Third	Stuart W. Morshead	Comparison of Predicted and Actual Performance of the Oldsmobile Rocket Engine	Stanford University
Fourth	Edwin S. Williams	Critical Evaluation of a Venturi Wind Tunnel	University of Santa Clara
Old Guard	Norman S. Fink	Mechanical Versus Electrical Tic-tat-toe	California Institute of Technology

REGION VII, PACIFIC NORTHWEST, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, B. C., CANADA, MAY 4, 6, 1950

Attendance: 200 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Delbert Robison	Calibration of the Oscilloscope for Use as an Engine Indicator	University of Idaho
Second	George Atherton	Why Waste It?	Oregon State College
Third	David Robinson	Construction and Operation of a Peach Cannery	University of British Columbia
Fourth	Paul W. Schmidt	The Five-Year Engineering Curriculum Expedient	Montana State College
Old Guard	Lawrence Onewein	The Design of a Hop-Picking Machine	University of Washington

REGION VIII, SOUTHERN TIER, SOUTHERN METHODIST UNIVERSITY, DALLAS, TEXAS, MARCH 31–APRIL 1, 1950

Attendance: 196 Papers Presented: 16

Prize	Recipient	Title of Paper	College
First	William R. Wilson	Photography of Strength	A&M College of Texas
Second	Eugene E. Pofahl	The Steam Turbine-Electric Locomotives of the Chesapeake and Ohio Railway	University of Texas
Third	James C. Flanagan	Look! No Hands	A&M College of Texas
Old Guard	Riley V. Carlton	Corrosion Fatigue of Drill Pipe	Texas Technological College

REGION VIII, NORTHERN TIER, KANSAS STATE COLLEGE, MANHATTAN, KAN., MAY 12, 13, 1950

Attendance: 207 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	William H. Strickland, Jr.	High-Octane Performance of Low-Octane Gasoline	University of Oklahoma
Second	Newton G. Koell	A Recent Horological Development	University of Arkansas
Third	James C. Johnson	Better Road Bases	Oklahoma A&M College
Fourth	Wilbur B. Evans	Gas-Turbine Locomotives	University of Kansas
Old Guard	Gerald R. Halter	Turbo-Hearth Steel Process	University of Nebraska

REGION VIII, ROCKY MOUNTAIN TIER, NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANICAL ARTS, STATE COLLEGE, N. MEX., APRIL 24, 25, 1950

Attendance: 180 Papers Presented: 14

Prize	Recipient	Title of Paper	College
First	William F. Cassidy	Predicting Wear in Diesel Locomotive Engines	University of Denver
Second	Roy W. Thomas	Closed-Cycle Gas Turbine	New Mexico College of A&M Arts
Third	Lory S. Conder	Roof Support in Coal Mines by the Use of Suspension Rods	Colorado School of Mines
Old Guard	Stephen Luchter	Proposed Applications of Welded Aluminum	Colorado A&M College
Fifth	Donald T. Moore	The Reaction Engine—Principles and Applications	Colorado School of Mines

Agriculture and Mechanic Arts, State College, N. Mex., with 180 in attendance. The visitors to this conference had a special treat—they were taken on a tour of the White Sands Proving Grounds where they had lunch and witnessed a rocket firing.

Region I

The Experimental Measurement and Analysis of the Torque Reaction on a Gas-Turbine Nozzle Row

By Philip Clifton Martin[1]

IT IS practically impossible to probe a turbine operating at high speed to study forces being exerted on such components as nozzle or blands. Yet such information, necessary to check theoretical design factors upon which future machines must be based, can be obtained by precise component testing in the laboratory.

Such a test was devised by the author to measure the torque reaction on the nozzle row of a turbocharger. The apparatus used, shown in Fig. 1, consisted principally of nozzle row and casing and an air intake. It was suspended by a torsion wire so fastened at the axis of rotation of the system that no "bucking" was exerted when the unit was displaced angularly by the torque rotation of the nozzle row.

When air was forced into the system and through the nozzles, the flow produced a torque reaction and a corresponding angular displacement of the system. By measuring displacement and calculating torque reaction for various flows and comparing these values against those obtained from theoretical calculations, it was found that experimental data deviated considerably from the theoretical.

What accounted for this deviation? A check on the angle of discharge of air from the nozzle was measured. This was found to be 27 degrees and not 21 degrees, the design angle of the nozzles. When account was taken of this 6-degree deviation, classical turbine theory gave theoretical results more in line with experimental results of the test.

Laboratory testing which aims to confirm theoretical results is an example of an engineering technique used to produce better turbines.

[1] Student member, ASME, Brown University, Providence, R. I.

Region II

The Analysis of Transient Vibrations by Means of a Mechanical Analog

By Joseph Engelberg[2]

WHEN a structure is subjected to periodic shocks, transient vibrations result. To determine the effect of the vibrations on equipment mounted on the structure, the equipment is assumed to vibrate as a system of one degree of freedom and is imagined to consist of a spring-mounted mass—the spring corresponding to the bolts with which the equipment is fastened to the structure, and the mass corresponding to the equipment itself.

A torsion pendulum can be set up to constitute a convenient dynamic analog which can be subjected to an excitation proportional to

[2] Student member, ASME, Cooper Union School of Engineering, New York, N. Y.

an acceleration record of an actual structure to yield a response which is proportional to that obtained by subjecting a single-degree-of-freedom spring-mounted mass of equivalent frequency to the same excitation.

The apparatus needed for such an analyzer consists of a torsion pendulum, two paper drives, a pickup arm, and a recording stylus. The angular displacement of the torsion pendulum is recorded on the lower paper drive. The acceleration record is placed on the upper paper drive. As the acceleration record moves past the fixed crossline, an operator moves the follower arm keeping the crossline on the graph. The top of the suspension wire is thereby given a deflection which is directly proportional to the excitation at any given time. From equations developed for the system, natural frequency and the acceleration of the spring-mounted mass can be calculated.

The maximum spring deformation which may be deduced from the maximum angular displacement of the pendulum bob for each particular pendulum frequency may be plotted as a function of the frequency of the spring-mounted-mass system: A maximum acceleration spectrum may also be plotted.

Such acceleration and displacement spectra can be useful in predicting the bolt deformation and acceleration of equipment subjected to transient vibrations. For example, in machine design when a factor of safety is increased, the weight of the machine is increased and its natural frequency decreased. In problems involving transient vibrations it is common to have maximum acceleration and displacement diminish as the natural frequency of vibration increases. Thus, paradoxically, an increase in the factor of safety in a machine structure may result in greater displacement and acceleration in case of shock and thereby result actually in a decrease in the factor of safety.

Region III

Rocket Motors

By Phyllis Evans[3]

A ROCKET motor is defined as one which operates entirely on its own propellant supply and which does not utilize atmospheric oxygen. It operates on Newton's third law of motion which states that to every action there is an equal and opposite reaction.

The power of a rocket motor therefore depends on what happens inside its combustion chamber. Its effective force is not the result of "pushing" on the atmosphere.

Control of a rocket missile depends on Newton's second law which states that direction of acceleration is same as that of accelerating force and inversely proportional to the mass of the particle. By changing the direction of the discharge gases, the direction of the rocket missile is changed.

Once a rocket missile emerges from the earth's gravitational sphere, it will continue at uniform velocity of emergence without further work on the part of the rocket motor. This is in accordance with Newton's first law.

[3] Student member, ASME, Drexel Institute of Technology, Philadelphia, Pa.

In its simplest form the rocket motor consists of a combustion chamber, nozzle, and igniter. The fuel charge may be either solid or liquid.

New fields are opening up for rocket motors using liquid propellants. Such motors require two or three tanks for the fuel system, depending on whether the fuel and oxidizer are fed by an inert-gas fuel system or by a turbine.

Solid rocket fuels usually consist of some form of carbon mixed with potassium nitrate cast in the combustion chamber. Among the liquid propellants, liquid oxygen and liquid hydrogen hold a high place.

Extremely high temperatures developed by a rocket motor pose a serious cooling problem for rocket designers. Various methods of evaporation and regenerative cooling have been devised to extend the temperature of present metals.

Although the German V-2 has given a great impetus to rocket development, enthusiasts know that it will be new fuels, perhaps some form of atomic energy, that will make their fondest dream—interplanetary travel—come true.

Region IV

The Fischer-Tropsch Process

By Paul M. Kruemcke[4]

A RECENT study of the world fuel situation showed that: (1) Cost of energy from any fuel will continue to rise; (2) long-range planning for fuels depends on coal; and (3) gas fuels and their derivitives must eventually come from coal.

The Germans, hard up for liquid fuels, led the world in developing synthetic gasoline and lubricants. During the last war they were producing 27 million barrels of oil annually by the Fischer-Tropsch process from poor coal called "braunkohle."

[4] Student member, ASME, University of South Carolina, Columbia, S. C.

In the Fischer-Tropsch process steam and oxygen are caused to react with pulverized coal at 2000 F to form a synthesis gas composed of hydrogen, carbon monoxide, and carbon dioxide. The synthesis gas is then changed into hydrocarbons by passing it through beds of cobalt catalyst at 650–700 F and 250–300 psi.

The great American contribution to the process was the development of the "fluidized-bed" to replace the cobalt catalyst. This consisted of pulverized iron oxide or nickel agitated into a "boiling" suspension by passing the synthesis gas through it.

The process can yield a variety of products: gasoline, Diesel oil, and heavy residual products, and city gas of 500 Btu per cu ft. The process, however, is not without fault. The by-products, for example, offer a problem. High quantities of N_2 and CO_2 resulting from the process do not have an adequate market. Heavy waxes and sulphides present a difficult chemical problem.

Pilot plants producing 10,000 bbl per day of gasoline and enough gas to supply a city of two million are in operation.

With the government spending 30 million dollars on the process, the synthetic-fuel industry offers an abundance of opportunities for mechanical engineers.

Region V

An Approach to the Generation and Utilization of Direct Current

By Raymond J. Slezak[5]

USE of direct current has lost favor as a power source because of transmission difficulties and the higher first cost and maintenance costs of d-c machines. Yet a d-c power system using machines without commutators is worth studying. Faraday developed a commutatorless d-c generator but it had no prac-

[5] Student member, University of Akron, Akron, Ohio.

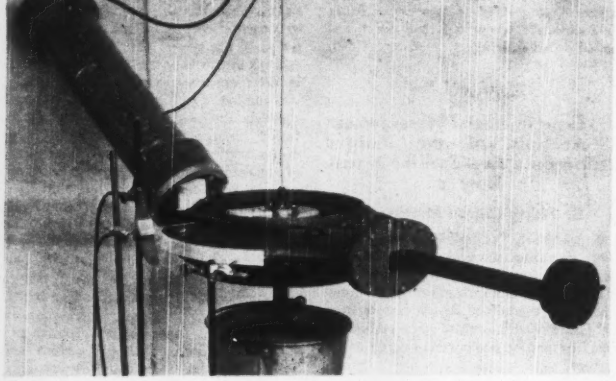


FIG. 1 ARRANGEMENT OF APPARATUS FOR DETERMINING TORQUE REACTION ON TURBINE NOZZLE ROW

tical application to power because of its low voltage output.

A novel approach to commutatorless direct-current generation of power is the fluid machine which uses an electrolytic liquid or gas flowing in a magnetic field. Such a machine using mercury was built by the author as a working model.

The model designed for motor action consists of a U-tube, the upper ends of which are connected to a reservoir. Four pair of electrodes connected in series are used, two on each leg of the U-tube. When the tube is filled with a conducting fluid such as mercury and a potential is imposed on the electrodes, the mercury in the tube completes the circuit and current flows. Now, if the tube-electrode system is placed in an electric field with the flux perpendicular to the U-tube, the circuit current cuts the magnetic field and a pressure develops in the mercury causing it to flow. If the flow is passed through a turbine, mechanical power can be taken from the system. If the reservoir is replaced by a pump, the system can be operated as a generator.

This principle can be used to develop a low-cost electric machine without brushes or commutators, capable of generating thousands of volts. Such a system using mercury vapor flowing at a velocity of 1000 fps through a field strength of 12,000 gauss, between electrodes 10 inches apart would develop a potential of 100 volts per pass. In effect the vapor system converts heat directly to electric energy. Because of its simplicity and economy, it warrants further development.

Region VI (Northern Tier)

Diesels Underground

By Arthur F. Dewsberry[6]

ECONOMY, reliability, availability—and in traction application, safety—recommend the Diesel engine as a power plant in coal and metal mines. Yet even with these advantages, Diesels do not dominate the mine-engine market.

Safety-conscious U. S. Bureau of Mines, with its strict mine-safety standards, stands between the mine market and Diesel manufacturers.

Mine Diesels must meet three safety requirements: (1) They must not discharge toxic or objectional gases in the exhaust; (2) temperature of engine parts must not ignite inflammable air mixtures in mines; (3) Diesel fuel must not introduce mine fire hazards.

Mine-safety standards require that exhaust be diluted to not more than 100 ppm CO_2, 25 ppm N_2, and 10 ppm aldehydes. To guard against the ignition danger, exhaust must be water-cooled below 150 F and provision made for automatic cutoff when the temperature reaches 180 F. No exposed engine part must be allowed to obtain a temperature greater than 400 F. All electrical mechanisms must be in explosion-proof casings. The fuel safety requirements are simple in comparison to the others.

So severe are these requirements that manufacturers usually find that the acceptable engine is competitively prohibitive. Some manufacturers are attempting to build engines of limited acceptability for use in special mines with some success.

But in spite of these obstacles the future of underground Diesels is hopeful. There is a general feeling in the industry, which is gaining recognition by the Bureau, that mine-safety standards are overly strict and that some of them have no validity in metal mines where inflammable-gas atmospheres do not normally occur.

[6] Student member, ASME, Northwestern University, Evanston, Ill.

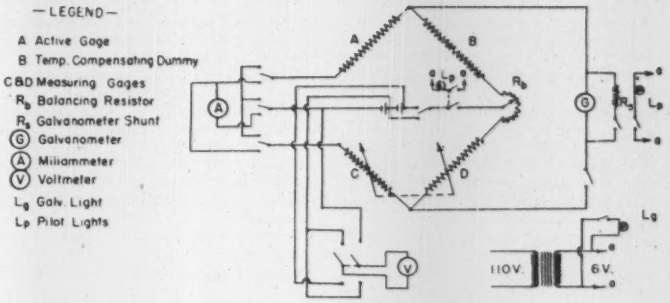


FIG. 2 CIRCUIT OF THE SR-4 STRAIN METER

Region VII (Pacific Southwest)

Design of a Strain Meter

By John M. Simonsen[7]

THE SR-4 gage in its simplest form consists of a fine wire grid cemented to a thin piece of paper. The resistance of this wire is directly proportional to its length and inversely proportional to its cross-sectional area.

The simplest of all SR-4 gage control circuits consists of an ammeter, a voltmeter, and a source of potential. Strain is determined by calculating resistance of wire before and after application of stress.

Use of a Wheatstone bridge type of a resistance-measuring circuit offers some advantages. In such a circuit, the variable resistors may be either of the circular type, a resistance wire with adjustable tap, or a system of using strain gages on a cantilever beam.

Because of its many advantages, the cantilever type is recommended. This consists of two SR-4 gages so arranged on a cantilever beam that when the end of the beam is deflected, one gage is in compression and the other in tension. The change in resistance is proportional to the deflection of the end of the beam, which can be determined by a micrometer. To extend the range of such an instrument, a resistance of about 6 ohms is added to the circuit.

Refinements may be added to the basic circuit, such as a battery checking voltmeter, a gage testing meter, a galvanometer shunt, and a voltage lowering device.

Fig. 2 shows the circuit of an instrument built by the author using many war surplus materials.

[7] Student member, ASME, University of Utah, Salt Lake City, Utah.

The instrument is calibrated in the following manner: Mechanical and electrical strain gages are placed on a specimen and the specimen is stressed just below its elastic limit in even steps. Readings of the change of strain indicated by the mechanical gage, and the change in micrometer readings necessary to keep the galvanometer reading at zero is recorded. From these data a constant is derived which when multiplied by the change in micrometer reading on the control device will equal the strain reading on the mechanical gage.

Now, whenever a strain measurement is needed, a SR-4 gage is placed on the member to be tested and the change in micrometer reading necessary to keep the bridge balanced as the member is stressed is multiplied by the constant previously found in order to determine the strain. The constant varies with the gage factor of the gages.

Region VIII (Southern)

Photography of Strength

By William R. Wilson[8]

NO complex engineering structure is built today without first subjecting the design to a complete stress analysis. Analytical methods of stress based on elementary formulas were an improvement on the old trial-and-error methods of analysis but were not entirely successful because they did not allow satisfactorily for stress concentration. Machines designed within specified allowable stresses often failed in service but failures were blamed on poor workmanship and faulty material rather than on faulty design.

Photoelastic stress analysis became known with the discovery in 1816 by David Brewer that various isotropic transparent materials such as glass and celluloid became doubly refractive under the action of stress. Application of this phenomenon was begun in 1891. Since 1940 the techniques have been refined so that photoelastic stress analysis now exceeds older methods in reliability and ease of application in stress analysis of unusual and complex shapes.

The method requires a polariscope which is an optical instrument producing circularly

[8] Student member, ASME, A&M College of Texas, College Station, Texas.

polarized light in which a model held in a loading frame is placed.

When circularly polarized light passes through a transparent material having doubly refractive properties under stress, one of three things happens: (1) Light will not be affected; (2) rotation of the polarized light will be reversed; or (3) the circularly polarized light will be distorted, producing elliptical polarization. What happens depends on the degree to which the material is doubly refractive and on the stress in the materials. Since stress in any member of a model varies from point to point, all three of these effects will be observed depending on the stress in the material. Stress concentration varies with the amount of light that will be passed through the model. Use of monochromatic light will show dark and light lines on the screen; a white light will give different-colored lines.

The method has a few disadvantages: (1) Cost of preparing model; (2) difficulty of loading it accurately; and (3) tendency of model to acquire residual stresses in machining. Equipment is also expensive and use of it requires skill.

Photoelastic method of stress analysis, however, has a definite place in industrial testing laboratories.

Region VIII (Rocky Mountain)

Predicting Wear in Diesel Locomotive Engines

By William F. Cassidy[9]

SPECTROGRAPHIC analysis of ash residue from lubricating oils removed from Diesel engines is a means by which Diesel-locomotive operators can check on the quality of such oils. By setting a limit on the amount of metal pickup tolerated, they can establish a quality standard enabling elimination of the poorer grades. The method also enables skilled technicians to predict wear in a locomotive and to order corrective measures before wear becomes excessive.

Although wear is usually defined as "a loss or removal of material from a body through corrosive or abrasive action," some lubricating oils show another type of wear that is due to an unknown property inherent in the oil. This property has been referred to as corrosive action because of its similarity to the effects of acid on a material, but some of its characteristics tend to disprove that this wear is entirely a corrosive action.

Nearly all lubricating oils tend to bite into metal surfaces being lubricated and to carry particles of this metal in suspension throughout the lubricating system. In a good oil, however, the pickup of metal does not continue indefinitely, but reaches a peak at which no further pickup occurs. By subjecting the ash residue of a sample of lubricating oil to spectrographic analysis, a determination can be made of the elements present in it. By comparing the changes in ash content of some base metal that is fairly uncommon in the Diesel engine, two indexes can be achieved: (1) A determination whether the part of the engine in which the metal occurs is being properly lubricated and (2) the amount of wear actually taking place in that area.

In the case of Diesel locomotive engines, a silver babbitt wrist-pin bearing is the hardest place to lubricate properly. Since silver is not present in any of the other bearings or parts of the engine, a determination of the silver content in the oil by spectrographic analysis, after approximately 5000 miles of service, can reveal the quality of lubrication being achieved.

While such analysis was not actually full quantitive analysis, techniques have been developed to indicate rather accurately the amount of metal picked up by comparing the spectrums with standards.

[9] Student member, ASME, University of Denver, Denver, Colo.

ASME Technical Radio-News Programs Now Available

A SERIES of 15-minute radio programs of technical news entitled "Engineering for a Better World" are now available from the editorial department of The American Society of Mechanical Engineers for use on college and community radio stations around the country. The series is designed to make people more conscious of what engineers and scientists are doing today to improve their daily living. The material for the programs is taken from articles appearing in the "Briefing the Record" section of MECHANICAL ENGINEERING.

This summer a series of these technical news programs were broadcast on a bi-monthly basis over radio station WSUI of Iowa City, Iowa, and this station is now presenting a fall series.

WRPI, Troy, N. Y., radio station of Rensselaer Polytechnic Institute, is also doing a fall series of these programs.

Persons interested in presenting a radio program of this type should write to J. J. Jaklitsch, Jr., editorial department, ASME, 29 West 39th Street, New York 18, N. Y.

Four Speakers to Address 1950 Junior Conference

THE fourth and final Junior Conference on the general theme, "How Is Your P.D.? (professional development)" will be held at 8 p.m., Monday, Nov. 26, as part of the 1950 Annual Meeting of The American Society of Mechanical Engineers. The Conference is being sponsored by the National Junior Committee with the aid of the ASME Old Guard Committee.

The other conferences, held in Washington, D. C., St. Louis, Mo., and Worcester, Mass., gave an opportunity for junior members of Regions III, VI, and I, respectively, to contribute their ideas about professional development. It was evident from these conferences that the apparent preoccupation of young engineers with economic status and material rewards was giving way before an earnest search for what a young man can do to make the most of his opportunities after graduation.

To meet the need for graduate guidance the National Junior Committee has invited four speakers to develop a clear program of self-help extending over the first five years of an engineer's career in industry. The topic selected for the Conference is, "The First Five Years After Graduation." Each speaker will suggest three to five specific things a graduate should do in one of the four categories: (1) Community relations; (2) registration; (3) evening graduate study courses; and (4) nontechnical reading. Each speaker will explore why these suggested steps to professional growth are important and what will be lost if they are neglected.

Karl B. McEachron Jr., manager, technical education division, General Electric Company, Schenectady, N. Y., will speak on what the young engineer should do in community relations.

The need to register will be discussed by H. L. Solberg, head, School of Mechanical Engineering, Purdue University, Lafayette, Ind.

J. C. McKeon, manager, university relations, Westinghouse Electric Corporation, East Pittsburgh, Pa., as third speaker, will take up the important subject of part-time graduate study. Concluding the series will be W. B. Embler, head, department of humanities, Cooper Union School of Engineering, New York, N. Y., who will give some advice on how graduate engineers can broaden their understanding of social and political forces by planned nontechnical reading. Donald E. Jahncke, chairman, National Junior Committee, will preside.

Opportunity

MECHANICAL engineers with ordnance experience are being sought by the U. S. Naval Ordnance Test Station in Inyokern, Calif., for a variety of positions involving research, development, and testing of rockets and guided missiles. Most positions to be filled are at the $4500 salary level. For further information contact Personnel Department, U. S. Naval Ordnance Test Station, Inyokern, China Lake, Calif.

ASME Calendar of Coming Events

Oct. 24–25
ASME Fuels Division Conference, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers was July 1, 1950)

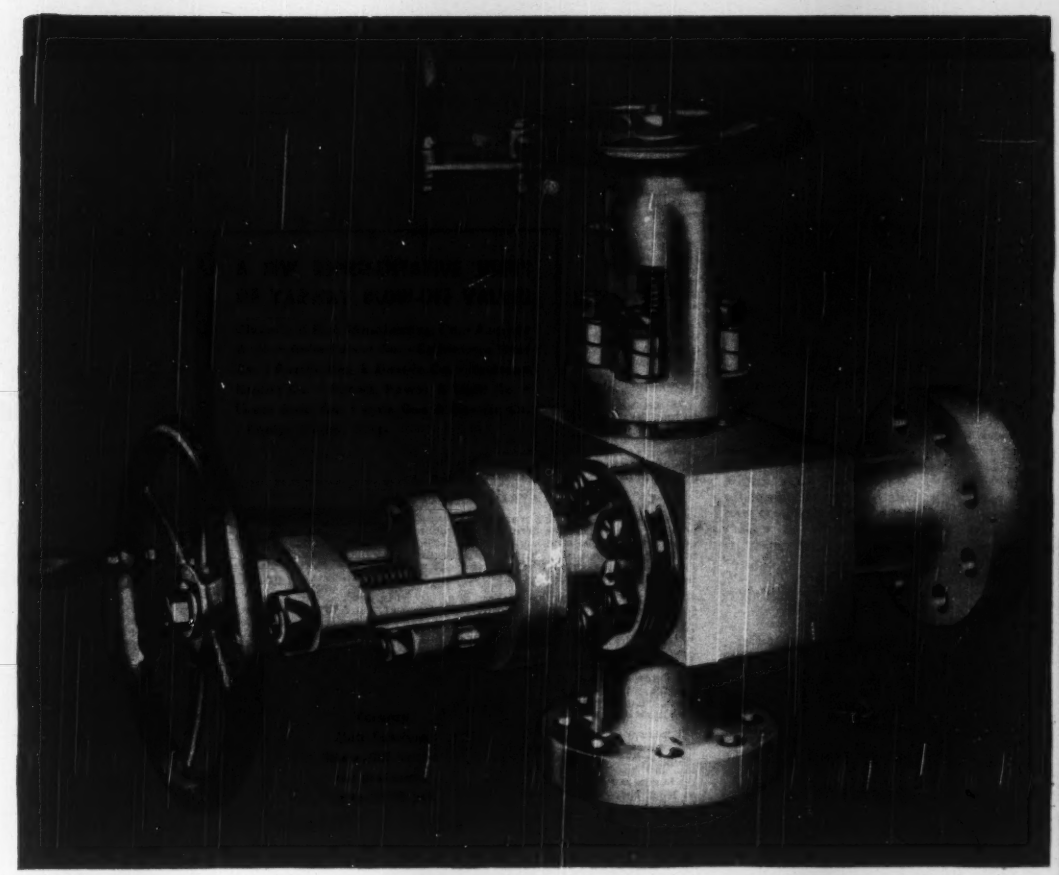
Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers was Aug. 1, 1950)

April 2–5, 1951
ASME Spring Meeting, Hotel Atlanta-Biltmore, Atlanta, Ga.
(Final date for submitting papers—Dec. 1, 1950)

April 17–19, 1951
ASME Process Industries Conference, Baltimore, Md.
(Final date for submitting papers—Dec. 1, 1950)

June 11–15, 1951
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(Final date for submitting papers—Feb. 1, 1951)
(For Meetings of Other Societies see page 839)

(ASME News Continued on page 856)



TIGHT! STRONG! for even toughest blow-down requirements

The Yarway Unit Tandem Blow-Off Valve meets the most demanding requirements for boiler blow-down or drain service.

It's drop-tight—and rugged enough to withstand the severe punishment of regular or emergency blow-down under pressure, or periodic acid wash.

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For more facts, see Yarway Bulletin B-432.

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Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.
Detroit
100 Farnsworth Ave.

Chicago
84 East Randolph Street
San Francisco
57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 22, BSME, June, 1949 graduate, single. One-year's experience in plastics. Desires position in wood products, furniture, or heavy machinery. Development, design, or sales engineering. Will relocate. Me-767.

MECHANICAL ENGINEER, 29, married, graduate cum laude, member PTS, TBP, American Industrial Hygiene Association, three and a half years' experience machine shop, one and a half years in industrial dust and fume control. Prefers Philadelphia, Trenton, Wilmington area. Me-768.

PROJECT-MECHANICAL ENGINEER, BSME, February, 1944, 29; six and a half years' experience in machine design, calculate shafting, gearing, bearings, cams, critical speeds, etc.; coordinate electrical-mechanical elements; purchase general machinery; follow through shops, testing to project completion. Desires work entitled above; capable of carrying on research, directing development of project; supervise drafting, machinists, electricians, junior engineers. Ill. or Milwaukee. Me-769-547 C.

MECHANICAL ENGINEER, graduate, 33, ten and a half years' experience designing, processing, tooling, and manufacturing aircraft gas-turbine components, automotive hardware elements, and naval machinery; plus proved administrative background, seeks eastern connection. Me-770.

MECHANICAL ENGINEER, honor graduate, BASc, 1940, desires sales engineer, executive assistant, preventive-maintenance position. Over ten years' experience in executive sales, preventive maintenance, design and development work with top firms. Me-771.

ENGINEER, 34, registered professional engineer; production and plant engineering, design chemical-process equipment, tablet presses, welded-steel-plate construction, ceramic equipment. Desires position as assistant chief engineer, chief draftsman, or salesman. Philadelphia area. Me-772.

MECHANICAL ENGINEER, BS, 34, single, nine years' thermodynamic power-plant analysis; design and stress analysis of rotating machinery and piping; experimental research. Seeks industrial or utility design or development work. Me-773.

MECHANICAL ENGINEER, 33, family, Stevens ME, registered professional engineer, ten years' industrial engineering; plant engineering, shop-work in cutting tool; woodworking, light assembly; fluorescent lamp; machine-tool plants. Desires small-plant administrative. Me-774.

MANUFACTURING EXECUTIVE, graduate mechanical engineer, many years experience in all phases of manufacturing including that of general manager and owner, and nine years in industrial engineering, available immediately. Has worked largely in small parts, mass production, woodworking and sheet metal with some heavy-machine work. Me-775.

OPERATING OR STAFF EXECUTIVE, registered industrial engineer in middle 30's, with line and staff experience in production, engineering, and top-management administration. Aggressive, cost-minded, and successful in getting union co-operation. Degrees in mechanical engineering and business administration. Me-776-601-C.

EXECUTIVE, 38, BSME, BSEE, MSEE, with well-rounded heavy-equipment background in management, sales, application engineering, and manufacturing. Employed in responsible management position, but will make change for good higher-level opportunity. Me-777.

MECHANICAL ENGINEER, 27, married, BSME, 18 months' training and three and one half years' experience supervising installation, inspection, and repair of turbogenerator units. Desires position as technical assistant to plant superintendent or as engineer with large consulting engineering firm. Eastern states preferred. Me-778.

POSITIONS AVAILABLE

MECHANICAL AND ELECTRICAL ENGINEER, extensive experience in the design, development, and manufacture of a wide variety of rotating electrical equipment under 30 hp, both a-c and d-c. Executive capacity and general shop experience required. Excellent opportunity. Conn. Y-3135.

DESIGNERS, recent graduates, interested in board design on turbines, centrifugal compressors, and heavy, rotating, electrical apparatus. Pa. Y-3923.

MATERIALS-HANDLING ENGINEER, at least ten years' experience in manufacturing and commercial fields, to make surveys, prepare reports, plan layouts in textile plants, and other manufacturing fields. Considerable traveling. $6000–$8000. Headquarters, New York, N. Y. Y-4015.

ENGINEERS. (*a*) Design engineer, 30–35, mechanical graduate, experience in design of air compressors, engines, fuel injection, etc., to design and lay out turbojet equipment. $6000–$7600. (*b*) Senior layout draftsman, mechanical graduate, at least three years' aircraft power-plant design experience, to design and lay out engine equipment. $4800–$5400. (*c*) Design analyst, mechanical graduate, static and dynamic stress and vibration experience covering heat-power equipment, to calculate and determine strength and sizes of components under high-temperature conditions. $4800–$6000. Long Island, N. Y. Y-4034.

SALES ENGINEER, 25–30, mechanical or civil graduate, single, office work covering routine correspondence, quotations, contacting customers, and field experience covering steel products for office work with steel importer. $3600. New York, N. Y. Y-4059.

MAINTENANCE ENGINEER AND SUPERVISOR, 35–45, engineering graduate, at least ten years' process-plant engineering and preventive-maintenance experience for staff position with industrial and household-products manufacturer. Some traveling. $6000–$7500. Headquarters, New York, N. Y. Y-4064.

PLANT SUPERINTENDENT, graduate, considerable experience with automatic screw machines, plating rooms, nickel and chrome, and buffing room; for brass plumbing company. Some experience in this field desirable. $7500. Upstate New York. Y-4067.

ENGINEERS. (*a*) Design engineer, 38–45, mechanical graduate, at least ten years' experience in power-plant design, to design boiler plant, piping and coal-conveyer installations. $6000–$7500. (*b*) Assistant design engineer, 28–35, mechanical graduate, five years' experience, to design elements of boiler plant, turbine room, and coal-handling installations. $4800–$5400. Eastern Pa. Y-4078.

MECHANICAL SUPERINTENDENT, 35–50, at least ten years' experience supervising plumbing, heating, ventilating on construction jobs for municipal project. $6000. Tenn. Y-4079.

MECHANICAL ENGINEER, thoroughly experienced in the design of all types of heating, air-conditioning, and ventilating systems, including systems for multistoried buildings, such as large apartment houses, hotels, office buildings, commercial buildings, etc. Must be registered engineer. Will head a mechanical-design section of an organization whose work is entirely building design, and will be in charge of the design of the above systems for these buildings. Duties will require discussions and contacts with clients and contractors. $10,000. S. C. Y-4085.

INDUSTRIAL ENGINEER, 32–38, at least five years' experience in surveys, plant layout and methods for staff position with consultant. Considerable traveling in East. $6500–$7500. Y-4101.

EXECUTIVE VICE-PRESIDENT, 40–45, engineering, production, and sales experience covering manufacture of fractional-hp motors, to take responsible charge of engineering, market development, new products, cost-reduction surveys for manufacturer of small motors. $18,000. East. Y-4119.

ADMINISTRATIVE ENGINEER, 35–50, preferably with advanced degree and at least five years' supervisory and co-ordinating experience covering research and development of electromechanical devices and equipment, to plan projects, co-ordinate progress, schedule staff meetings, supervise correspondence, budgets, and general office details. Some traveling. $7600–$8000. East. Y-4141.

VICE-PRESIDENT, 45–50, mechanical graduate, engineering, production, and executive experience in metal-products and stamping field, to take charge of metalworking plant. $20,000–$25,000, plus bonus. New England. Y-4142.

DESIGNER, over 30, ten years' experience designing automatic machinery, preferably packaging equipment. Knowledge of paper and cardboard handling. Will design and develop automatic packaging machinery and do own board work, but no detailing. $6500–$7800. Ill. R-6770.

ENGINEERS. (*a*) Designer, mechanical, 27–37, considerable experience in end-product design of pumps, hydraulic and pneumatic, desirable. Experience with the following acceptable: gas pumps, refrigerators, washing machines, vending dispensing equipment, etc. Must be able to work on the board and assume responsibility at a project level for a manufacturer. (*b*) Product-development engineer, mechanical, 27–37, considerable experience in developing from end-product designs of pumps, hydraulic and pneumatic, experience with gas pumps, refrigerators, etc., acceptable. Must be able to work on board and to head up a group for a manufacturer. (*c*) Design-research engineer, mechanical, 27–37, considerable experience in carrying out original investigations in connection with mechanical end-product development of pumps, hydraulic and pneumatic. Experience in gas pumps, refrigerators, etc., acceptable. $6000–$7000. Mich. R-6771.

ENGINEERS. (*a*) Project-development engineer, five years' experience developing small refrigeration units and able to carry project through to completion. Knowledge of manufacturing for project work on refrigeration units for a manufacturer. $6500–$8500. (*b*) Chief designer, mechanical, 30–45, five years' experience on machine and product design in medium to heavy fields. Ability to supervise draftsmen and designers. Knowledge of automatic equipment helpful. Informed about production operations. Will direct 20 to 25 draftsmen and designers working on machines and products for a manufacturer of refrigerating and fountain equipment. $6500. Ill. R-6799.

[1] All men listed hold some form of ASME membership.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Oct. 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALDRICH, DAVID E., Caldwell, N. J.

(*ASME News Continued on page 858*)

SHOPPING FOR BLOWERS?

Type OIB Centrifugal Blower in midwestern chemical plant. Capacity 19,600 cfm.

Look at *R-C dual-ability* with its wide selection to suit almost any job

Asking Roots-Connersville about blowers, exhausters and gas pumps has been standard practice among buyers for almost a century. That's because building such equipment is the only job we do. We're outstanding specialists in handling gas and air.

You'll gain from our wide varieties of sizes, types and capacities from 5 cfm to 100,000 cfm. We're the only manufacturers offering you the *dual-choice* between Centrifugal and Rotary Positive designs—and that *dual-ability* is important when it comes to matching the units to the jobs to be done.

So—when shopping, be sure to call on Roots-Connersville, the specialists. When you're interested in vacuum pumps, meters or inert gas generators, we're equally well-fitted to fill these needs, too.

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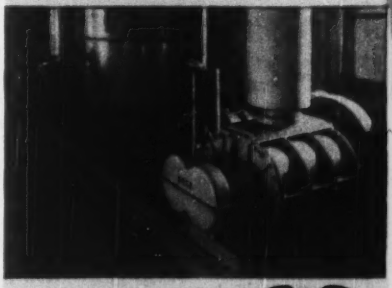

Rotary Positive Blower used for pneumatic conveying in eastern food manufacturing plant.

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ALTMAN, OTTO, Port Chester, N. Y.
ALVORD, HERBERT H., Ann Arbor, Mich.
BARNARD, CLAYTON H., Cleveland, Ohio (Rt&T)
BATRA, SARV PRAKASH, Philadelphia, Pa.
BENNETT, GEORGE C., Long Island City, N. Y.
BONGIRNE, JOHN THOMAS, Brooklyn, N. Y.
BRODERICK, WALTER M., Springfield, Mass.
CARRABINO, JOSEPH D., Los Angeles, Calif.
CHABRE, GASTON L., Los Angeles, Calif.
CHAPMAN, ROBERT L., Port Washington, N. Y.
CUNNINGHAM, RICHARD G., Crystal Lake, Ill.
DUNN, FENMORE E., Union, N. J.
DUROCHER, JOSEPH D., JR., New York, N. Y.
EAMES, ELIOT N., Arlington, Mass.
EATON, FRANCIS C., Ridley Park, Pa.
FULTON, PAUL W., Yonkers, N. Y.
GARWOOD, JACK HARLAN, Gary, Ind.
GSHRINGER, PAUL L., New York, N. Y.
GRIEVE, JORGE ALEJANDRO, Lima, Peru, S. A.
GUPTA, OM PRAKASH, Philadelphia, Pa.
HANNIGAN, JOHN, Kingston, Pa.
HAUPT, KARL W., Cincinnati, Ohio
HAYS, LAWRENCE C., Cleveland, Ohio
HAZELRIGG, WAYNE K., Chicago, Ill.
HORVAY, GABRIEL, Schenectady, N. Y.
JACKSON, HERBERT B., Houston, Texas
JORGENSEN, ARNOLD T., Glenwood Landing, N. Y.
KEATOR, HAROLD E., JR., Palmerton, Pa.
KENT, HARRY S., Flushing, N. Y.
LAKE, ADDISON A., Los Angeles, Calif.
LEISEY, LEVI B., Ephrata, Pa.
LUBBERS, ADOLPH WILLIAM, Chatham, N. J.
MASON, FRANCIS MARION, Chicago, Ill.
MCCALEB, CHARLES M., Corpus Christi, Texas
MCCONNELL, ROBERT J., Whitinsville, Mass.
MCGAHAN, WALLACE A., Phillipsburg, N. J.
MELCHIOR, OSCAR G., Ho-Ho-Kus, N. J.
MILLIAN, JAMES Z., Pittsburgh, Pa.
MILLSPAUGH, STANLEY C., Oneonta, N. Y.
MOFFATT, CHESTER C., San Gabriel, Calif.
MOORE, WAYNE R., Ames, Iowa
MOSELEY, JOHN W., Whittier, Calif.
MUKHERJEE, S. K., Calcutta, India
OSBORNE, WILLIAM O., Glens Falls, N. Y.
PANDORFF, EDWARD CARL, Cincinnati, Ohio
PARKER, DEWILTON F., Los Angeles, Calif.
RITNER, FORD C., Detroit, Mich.
ROBINSON, MORTON L., New York, N. Y.
SATRE, CLIFFORD M., Jewell, Iowa
SCHUSTER, HERBERT R., Oradell, N. J. (Rt&T)
SCHWARZER, CARL J., E. Pittsburgh, Pa.
SEATON, ARNOLD E., Putnam, Conn.
SEAVEY, FREDERICK R., St. Paul, Minn.
SEWELL, J. L., Corpus Christi, Texas (Rt&T)
SKILLING, THOMAS R., JR., Pittsburgh, Pa.
SMITH, HURLAND F., JR., Corpus Caristi, Texas
SOROS, PAUL, New York, N. Y.
SPADARO, CARMEN S., Syracuse, N. Y.
SPENCE, RICHARD F., York, Pa.
STALLMEYER, JAMES E., Champaign, Ill.
STREVES, EDWARD A., Jamaica Plain, Mass.
THOMAS H., EMERSON, Westfied, N. J.
THORLEY, THOMAS J., Long Beach, Calif.
TRAUB, SAMUEL H., Minneapolis, Minn.
TRICKEY, PHILIP H., Webster Groves, Mo.
TROSKE, GERALD J., Bay City, Mich.
VAN ZYL, CORNELIUS J., Discovery, Transvaal, South Africa
WADDELL, CHARLES E., Brooklyn, N. Y.
WALDO, ARTHUR M., Toledo, Ohio
WATMUFF, DENNIS, Hastings-on-Hudson, N. Y.
WAUGAMAN, CHARLES H., Clarks Summit, Pa.
WEBB, WILLIAM L., New York, N. Y.
WILSON, M. N., JR., Los Angeles, Calif.
WOODHEAD, HENRY A., JR., Graniteville, S. C.
WU, CHUNG-HUA, Cleveland, Ohio

CHANGE IN GRADING

Transfers to Member and Associate

ADAMS, JAMES F., JR., Syracuse, N. Y.
ALBERT, JOSEPH A., St. Louis, Mo.
ALLEN, JOHN LEE, Los Angeles, Calif.
BESSERER, CARL W., Silver Spring, Md.
BRUGELMANS, ALEXANDER, Hoboken, N. J.
CASHIN, FRANCIS J., JR., New York, N. Y.
CHERNIAK, GEORGE S., Boston, Mass.
COUCH, HAROLD K., Charlotte, N. C.
CROCKER, SABIN, JR., Cohasset, Mass.
DAVIDSON, JAMES R., Rochester, N. Y.
FINKL, CHARLES W., Chicago, Ill.
GILMAN, RAY EDWARD, Hot Springs, Ark.
GUNDRUM, JOHN HARRY, Lampeter, Pa.
HARDWAY, JOE P., JR., San Diego, Calif.
JAKLITSCH, J. J., JR., Woodside, N. Y.
KENNISON, GEORGE F., Litchfield, Conn.
KISHIBAY, CHARLES O., Bridgeport, Conn.
LEWIS, BRUCE E., Charleston, S. C.
MACCRACKEN, CALVIN D., Tenafly, N. J.
MARSHALL, DANIEL Q., Lockland, Ohio
MINGLEDORFF, W. L., JR., Savannah, Ga.
MURPHY, E. A., JR., Willow Grove, Pa.
NELSON, CARL W., Berkeley, Calif.
NEWTON, ROBERT E., Clayton, Mo.
NIEMEIER, B. A., Richmond, Va.
NORDHIELM, BERNDT, Black Mountain, N. C.
PARENT, DONALD F., Schenectady, N. Y.
PARRISH, J. RUSSELL, Des Moines, Iowa
PARSONS, JAMES L., Wilmington, Del.
PAUTLER, ANTHONY C., Old Saybrook, Conn.
PLINER, NORMAN S., Cumberland, Md.
POMERANZ, ROBERT E., Sanford, N. C.
REIS, KURT H., Roslyn Heights, N. Y.
STAMETS, WILLIAM K., JR., Bellevue, Wash.
STRONG, HERBERT D., JR., Montrose, Calif.
STROUD, WILLIAM E., Corning, N. Y.
VANCE, EDWARD M., Arcadia, Calif.
VAN VALKENBURG, JAMES F., Collingdale, Pa.
WOOLRICH, PAUL F., Salt Lake City, Utah

Transfers from Student Member to Junior 200

Obituaries

John Collins, Jr. (1892–1950)

JOHN COLLINS, JR., chief engineer, Socony Vacuum Oil Co., Inc., Brooklyn, N. Y., died at his home in Paterson, N. J., July 10, 1950. Born Paterson, N. J., Jan. 6, 1892. Parents, John and Catherine A. (Fitzgibbons) Collins. Education, ME, Stevens Institute of Technology, 1913. Married Katherine Marcella Gaherin, 1914. Assoc. ASME, 1921; Mem. ASME, 1928. Survived by wife and two children, Mrs. Katherine M. (Theodore) Van Kerschaver and Edwin John.

Glenn Cook Hyde (1882–1950)

GLENN COOK HYDE, president, Gulf Public Service Co., Inc., Dallas, Texas, died June 23, 1950, of a heart attack. Born, Hebron, Ill., Jan. 2, 1882. Parents, William Church and Marietta (Cook) Hyde. Education, BSEE, Purdue University, 1906. Married Sarah Mitchell, 1915. Assoc. Mem. ASME, 1916; Mem. ASME, 1935. Survived by wife.

Arthur Frederick Johnson (1889–1950)

ARTHUR F. JOHNSON, professor, mechanical engineering, George Washington University, died June 8, 1950. Born, New York, N. Y., June 27, 1889. Parents, John Magnus and Mary Johnson. Education, NA, Webb Institute, 1911; ME, George Washington University, 1915. Married Evelyn Huebner, 1912; son, Frank Calvin. Author: "Design and Construction of Power Work Boats" and "Applied Descriptive Geometry"; several technical papers. Mem. ASME, 1924; Fellow ASME, 1949. Survived by wife and son.

Pedro Martinto (1871–1945)

PEDRO MARTINTO, whose death was recently reported to the Society, was president, Pedro Martinto, Inc., New York, N. Y. He died in Lima, Peru, S. A., May 25, 1945. Born, Ossés, Basses Pyrénées, France, Nov. 2, 1871. Education, BS, Cooper Institute, 1899. Naturalized citizen of U. S. A. Married Teresa Carroll. Assoc. ASME, 1901. Survived by wife (died 1948) and six children, Albert, Pedro, Teresa, Mercedes, Lucia, Isabel.

Richard Addison Smart (1872–1950)

RICHARD A. SMART, retired in 1948 as New England representative, North American Manufacturing Co., died July 17, 1950, in Tyron, N. C. Born, Fort Wayne, Ind., Nov. 18, 1872. Parents James H., who was for some time president of Purdue University, and Mary H. (Swan) Smart. Education, BSME, Purdue University, 1892; ME, 1894. Married Elsie D. Moore, 1901 (died 1948). Author: "Handbook of Engineering Laboratory Practice" and several technical articles. Jun. ASME, 1894; Assoc. ASME, 1900; Mem. ASME, 1906. Survived by two children, Douglas Levering (Mem. ASME) Grosse Pointe Park, Mich., and Marjorie (Mrs. René A.) Müller, Detroit, Mich.

Walter Edgar Wollheim (1884–1950)

WALTER EDGAR WOLLHEIM, mechanical engineer and patent-law counselor, Nathan Manufacturing Co., New York, N. Y., died July 29, 1950. Born, Breslau, Germany, March 14, 1884. Parents, Bessalie and Paula (Nathan) Wollheim. Education, Aachen Technical School, Germany; Cooper Institute (Engineering); New York University Law School (Patent Law); New York University (Steam Engineering). Naturalized U. S. citizen, Sept. 26, 1906, New York, N. Y. Married Margot Wollheim, 1905 (died 1942). Married 2nd, Hannah Guttman, 1944. Assoc. Mem. ASME, 1917; Mem. ASME, 1920. Survived by wife, a son, Ralph J., and a grandson.

ASME Master-File Information

(Not for use of student members)

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Name ..... (Last — First — Middle)

Home address ..... (Street — City — Zone — State) ☐

Name of employer .....

Address of employer ..... (Street — City — Zone — State) ☐

Product or service of company .....

Title of position held .....

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The plane hasn't been built that is too big to land at Friendship International Airport. Nor is it likely to be. For in designing this new 3000 acre giant, formally opened by President Truman on June 24 to serve the Baltimore-Washington area, the keynote was expandability.

To Friendship's engineers, this meant not only providing for future passenger and cargo traffic, but selecting equipment on the basis of *long service life and safety.* That's why at Friendship, as in so many of the postwar air terminal and other large buildings designed with Tomorrow in mind, Jenkins Valves are installed.

Jenkins builds extra endurance into valves — proved time and again by low upkeep cost records in every type of service. Yet, you pay no more for Jenkins Valves, despite this extra value. Let the Jenkins Diamond be your guide to valve economy . . . for new installations, for all replacements. Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros., Ltd., Montreal.

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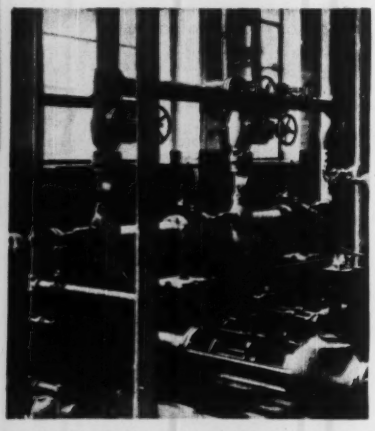

BEHIND THE SCENE at Baltimore's $15 million Friendship International Airport, this view shows several of the 683 Jenkins Valves on 24-hour duty, policing steam, air, water and fire lines.

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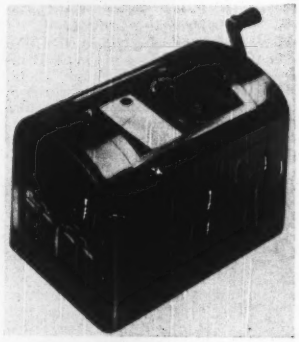
Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

New CVM Type of Megger Ground Tester

. . . for measuring resistance to earth of ground connections.

It provides a dependable and easy method for ascertaining if the resistance to earth of man-made grounds is sufficiently low to ensure their correct operation and to minimize dangers due to lightning.



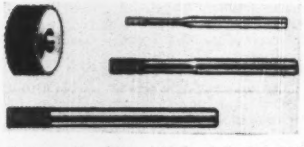
This modern, improved set has its own generator for supplying test current and is therefore always ready for service without dependence on battery or other supply.

The unique terminal arrangement employs two switches which short-circuit the terminals for 2, 3 and 4 terminal tests.

Each instrument has two scales, permitting open, well-proportioned markings. Two ranges are available, 0 to 40 and 0 to 200 ohms; 0 to 100 and 0 to 500 ohms.

Complete information on this new instrument is contained in Bulletin 25-80-50 available on request from James G. Biddle Co., 1316 Arch St., Philadelphia, Pa.

Solid Carbide Grinding Tools Cut Grinding Time on Small Parts; Increase Accuracy



A group of carbide tools that is finding wide application for the internal and jig grinding of small holes in both soft and hardened steels (up to Rockwell C-65) as well as in other engineering metals are carbide grinding tools similar to those shown in the accompanying illustration. Made of solid Carboloy cemented carbide, these tools are said to hold size, produce a fine finish and last longer than conventional grinding wheels.

In one shop, for instance, average production on the internal grinding of hardened steel collets (Rockwell C-62 to C-65) was between 10 and 20 units per wheel with abrasive type wheels. Sometimes only 2 or 3 collets could be obtained per wheel. Time required to grind each collet averaged 5 minutes. Grinding tools made of Carboloy cemented carbide cut grinding time to 2 minutes per unit and 218 collets were finished with one tool. The tool was then resharpened at small cost. Downtime of equipment obviously was also reduced.

In another shop, it took 5 hours and 6 conventional grit wheels to locate holes on a particular drill jig. The same job was performed in 17 minutes with a carbide grinding tool. Tolerance maintained for hole location was also within .0002", an accuracy previously unobtainable.

New Stabilized D-C Indicating Amplifier

Multi-purpose Stabilized D-C Indicating Amplifiers just announced by Leeds & Northrup Co. are useful for low-level d-c measurements as direct-reading microvoltmeters or microammeters; as recorder pre-amplifiers to extend the range of standard Speedomax Recorders; and as high-sensitivity, short-period null detectors in place of galvanometers. Amplifiers are supplied either as voltage or current type, with choice of zero-left or zero-center built-in 4-inch indicating meter.

Both gain and zero point are so highly stabilized by a combination of a-c amplification and d-c null-balance feedback that trimmer controls are unnecessary. Without impairing performance, the voltage amplifier can be used with sources up to 10,000 ohms resistance, and the current type with sources of 100,000 ohms and higher.

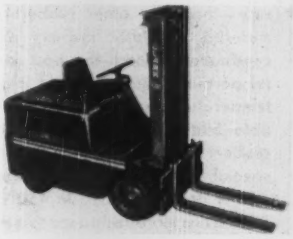
Basic range of the voltage amplifier is 0 to 50 or −25 to +25 microvolts, with scale multipliers of 1, 2, 4, 10, 20 and 40; of the current amplifier, 0 to 1000 or −500 to +500 micro-microamperes, with multipliers of 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, and 2000. Response time of both models is 2 to 3 seconds. Output at recorder connector for full-scale input on any range is 10 millivolts at output impedance of 500 ohms.

For convenience in null balance measurements, the indicating meter can be switched to non-linear response. This type of response retains full sensitivity where needed, in the region of the zero point, but gradually decreases sensitivity toward the ends of the scale, to prevent large unbalance inputs from sending the meter off scale.

For full details, write to Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Clark Gas Carloader Now Available With New Dynatork Drive

The Clark gas-powered Carloader, said to be the most widely used model of fork-lift truck ever built, is now available with the new Dynatork Drive, according to an announcement by the Industrial Truck Division of the Clark Equipment Co.



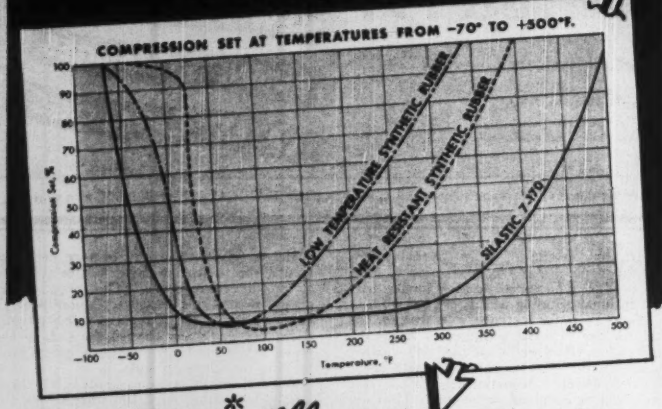
Introduced in 1938, the Carloader won high acceptance almost immediately through its rugged strength and the compact dimensions which enabled it to operate with ease and efficiency into and out of railroad freight cars. Its capacity for work and its extraordinary versatility are credited generally with advancing and broadening industry's concept of the fork-truck's usefulness. It is acknowledged, too, that the Carloader has done more than any other fork-truck model ever built to establish Mechanized Materials Handling as an indispensable phase of modern high-speed, low-cost production.

Similarly, the revoltutionary Dynatork Drive, exclusive with Clark, marks a major advance in the development of Materials Handling as an industrial science in its own right. By increasing as much as 20 per cent the amount of work a fork-lift truck can do, this new type of power-transmission cuts deeply into handling costs. It accomplishes that increase in work-capacity by making more efficient use of the power created by the engine.

The Dynatork Drive transmits engine power to the drive wheels by magnetic induction, through an air gap. There is no friction-type clutch; and the conventional transmission is replaced by a constant-mesh, 2-speed forward-and-reverse gearing. Several sources of wear are eliminated; and reduced maintenance and servicing requirements represent a major advantage for users.

Continued on Page 40

Where ordinary rubber gaskets fail . . .



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AT EXTREME TEMPERATURES, Silastic has greater resistance to compression set—or to permanent deformation due to heat and pressure—than any other rubberlike material. Its elastic memory exceeds that of both the best low temperature and the best high temperature organic rubbers available. Silastic 7-170 forms a more resilient seal at −50°F. than a special low temperature organic rubber does at −7°F. At 450°F., Silastic has more resistance to permanent compression set than the most heat-stable organic rubbers have at 330°F.

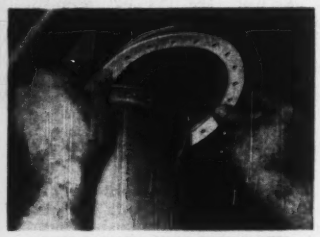

PHOTO COURTESY CONSOLIDATED VULTEE AIRCRAFT CORP.

In aircraft cabin heating and pressurizing systems, Silastic gaskets stay elastic under operating temperatures ranging from −70° to 400°F. Similarly, Silastic gaskets and O-rings withstand hot oils in the range of 450°F. in automotive, aircraft and diesel-electric engines.

COMBINE that kind of elastic memory with excellent resistance to aging, to oxidation and to attack by a variety of chemicals and hot oils, and you have Silastic—the most stable of all resilient gasketing materials. That's why design engineers and maintenance men specify Silastic, the Dow Corning Silicone rubber that pays for itself many times over in reduced maintenance costs and improved performance.

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In general, the Dynatork Drive eliminates jerks, repeated shifting of gears when operating in close quarters, and excessive waste of power. "Inching" for maneuvering in tight quarters is accomplished by almost effortless depression and release of a foot-pedal. Direction of travel may be reversed by finger-tip flip of the forward-and-reverse control lever mounted on the steering column. The Dynatork Drive is the only power-transmission device that permits reversal of direction without first bringing the machine to a full stop.

In keeping with the "Safety First" slogan which keynoted the development of Dynatork Drive, an added safety device has been incorporated in the new Carloader, which returns the direction-control level automatically to "neutral" the instant the driver leaves his seat—and locks it in "neutral." The lever cannot be moved from neutral until the driver resumes his seat, or until equivalent weight depresses the seat to the unlocking point.

Full information concerning this union of two of the most important of all materials handling developments will be furnished in response to requests addressed to the Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

Electronic Press Drive Equipment Aids Printing Industry

Many major printing plants throughout the country are switching to electronic press drives, according to W. V. Gough, Manager of General Electric's Printing Industries Section. Five large newspapers are already operating with G-E electronic drives, and 13 other newspapers have placed orders for delivery.

This modern drive provides closer speed control and more flexibility at less cost, compared with conventional a-c drives. At the Buffalo Courier-Express, engineers reported a 27 per cent saving on demand charges with the new drives. Power savings alone range from zero at maximum geared speed to 50 per cent at half speed.

The problem of removing heat from the control room is reduced with electronic controls as the secondary load resistor losses are eliminated. This also reduces maintenance costs.

The first such drive was installed in the Philadelphia Inquirer plant in August, 1948, for its multi-million dollar rotogravure plant and its black and white presses. Since that time, The Dallas Morning News, The Buffalo Courier-Express, The Denver Post, and The Los Angeles Times-Mirror have installed electronics to drive and control their presses.

Constant-voltage rectification for d-c motor drives using the electronic tube was devel-

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oped several years ago. About the same time, a variable-voltage system was developed. This allowed fully variable field and armature voltage to increase the speed range and control for a d-c motor. But this was confined to drives of relatively small horsepower. The new drive combines the best features of both of these systems.

The tubes operate off 440 volts without intermediate transformers and are controlled by a completely static magnetic circuit. Through the use of phase control, the output can be varied from zero to 550 volts d-c. This d-c voltage is then applied to a-c driving motors through customary magnetic control and selection systems to give a smooth, dependable press drive, made especially for the printing industry.

Traffic Note—
Fresh Air a Travel Expense

Philadelphia—One item of travel expense motorists don't mind paying is that for keeping air fresh in the nation's vehicular tunnels.

Without the fresh air, the trip-shortening passageways would be useless because of poisonous exhaust gases, but it requires some mammoth drafts to turn the trick.

Fifty-three huge fans ventilating the newly-opened Brooklyn-Battery tunnel linking Manhattan and Brooklyn can force a maximum of 4,150,000 cubic feet of fresh air through the 9,117-foot underwater link at one time, according to SKF Industries, Inc. This alone is the equivalent of about four tornadoes, say engineers.

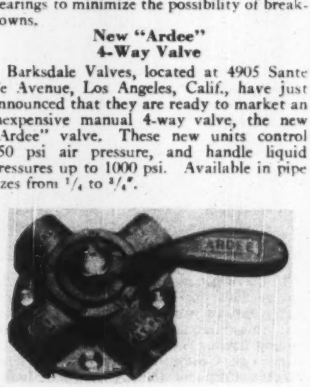
Although shorter in length, the Lincoln tunnel connecting New Jersey with mid-Manhattan requires 56 fans which change the air inside the tubes every 70 seconds. New York City's Queens Midtown tunnel has 46 fans. Special carbon monoxide recorders keep constant check on gas concentration.

The seven tunnels which cut through mountains on Pennsylvania's famed 160-mile non-stop turnpike between Harrisburg and Pittsburgh have 26 fans to keep the air continually in motion. It takes five fans to ventilate the Bankhead tunnel under the Mobile river at Mobile, Ala., and three for the new Washburn tunnel under the Houston river at Houston, Tex.

Virtually every tunnel fan installed since 1937 has been equipped with spherical roller bearings to minimize the possibility of breakdowns.

New "Ardee"
4-Way Valve

Barksdale Valves, located at 4905 Sante Fe Avenue, Los Angeles, Calif., have just announced that they are ready to market an inexpensive manual 4-way valve, the new "Ardee" valve. These new units control 150 psi air pressure, and handle liquid pressures up to 1000 psi. Available in pipe sizes from $^1/_4$ to $^3/_4$".



Their design is a variation on the sealing principle which is so successfully employed in Barksdale high pressure valves. A tubular sealing member slides over the peripheral surface of a rotor, maintaining intimate con-

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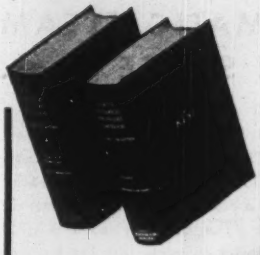

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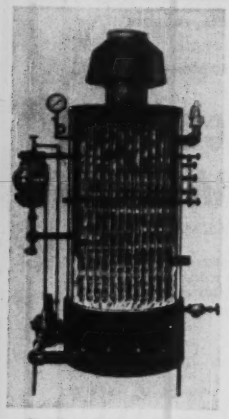

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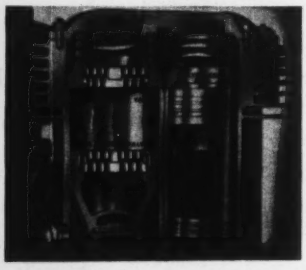

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tact during operation of the valve. Pipe scale and foreign material in the line cannot lodge between the sealing surfaces, due to the wiping action of the sliding seal.

Valve bodies, depending on service, are furnished in aluminum or brass, and the tubular sealing members are molded of various resilient materials suitable for the service requirements. The controlled degree of softness assures a tight seal against the curvature of the mating surface.

There is minimum pressure loss through the valve because the round internal flow passages are unobstructed and of the same diameter as the nominal pipe size. The non-interflow characteristic of the "Ardee" valve is important for operations where infinitely variable throttling is desirable, as on materials handling equipment, farm implements and road machinery; operation of the valve is not affected by vibration.

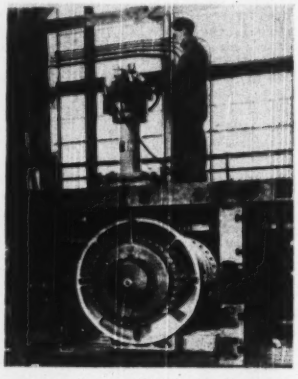
New Metering Element for Fluid Flow is Compact and Simple to Install

The Foster "Flow Tube" is a new development in primary elements for the measurement and control of fluid flow. It is essentially a differential producer which can be used with properly calibrated conventional recording, indicating, integrating, or control instruments.

The device consists of a short spool piece with an inner sleeve equipped with two groups of pressure nozzles, one set pointing upstream and the other downstream. These nozzle groups are interconnected by common pressure rings from which connections are made to the meter.

Flow tubes are made in three fundamental types and in all standard pipe sizes. Advantages claimed are compactness, high accuracy, and economy of installation and use. Made under Gentile Patents by Foster Engineering Co., 835 Lehigh Ave., Union, N. J. Described in Bulletin FT.

Discharge Valve Reduces Spray and Erosion



In the outlet end of this hollow jet-free discharge valve for Pacoima Dam, California, water and air will be mixed to form a "soft jet," thus minimizing spray and erosion in the stilling basin. The valve was built at the Sunnyvale, California, plant of Westinghouse Electric Corp. for the Los Angeles County Flood Control District.

The action of the water flow draws air in through the four rectangular apertures visible at the top, bottom and sides of the outlet face. The resulting tubular-shaped discharge is filled with thousands of bubbles trapped in the stream. This aeration

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cushions the force of the water against the stilling bed, and also acts as a cohesive agent to reduce misting.

Westinghouse Electric Corp. is the licensed builder of this type of valve, which is designed for dams that discharge water onto erodable soil, or for installations where it is desirable to eliminate excessive spray and mist in the vicinity of the dam.

Award Contract For World's Largest Vacuum Flasher

As part of a general modernization program at its Richmond (California) refinery, the Standard Oil Co. of California has awarded a contract for what is considered the world's largest vacuum flashing unit to The M. W. Kellogg Co., it was announced by this refinery and chemical engineering firm of Jersey City, N. J. The unit will be able to charge 55,000 barrels of reduced crude a day.

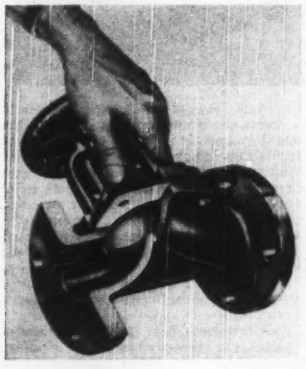
According to Kellogg, the main vessel in the unit will stand 80 feet high and will have a maximum diameter of 27 feet. Its design capacity is believed to exceed by 15 per cent the largest vacuum unit currently in operation.

The unit is being designed to provide approximately 30,000 barrels of feed each day for the existing catalytic cracking unit at Richmond, which is scheduled for revamping during the modernization. Asphalt—the other major product from the flasher—will be charged to visbreakers to produce high quality fuel oil and gasoline.

Scheduled for completion in May of 1951, the new unit will charge not only reduced crude from California's Richmond and El Secundo refineries, but will also process some heavy, so-called "non-refinable" crudes.

Grinnell-Saunders Diaphragm Valves

A new chemically inert diaphragm for Grinnell-Saunders Diaphragm valves has successfully completed its field testing and is now offered to industry by Grinnell Co., Inc. This thermo-plastic (KEL-F*) has been successfully moulded to form a tough and very flexible valve diaphragm which withstands such hard-to-handle materials as Chlorinated aliphatic and aromatic compounds, concentrated Nitric, Chromic, Hydrofluoric and Sulphuric acids, and most solvents which readily attack rubber and synthetic diaphragm materials.



The new diaphragms are available only for Grinnell-Saunders Diaphragm valves which have been altered to permit the use of a backing sheet which cushions and protects

Continued on Page 44

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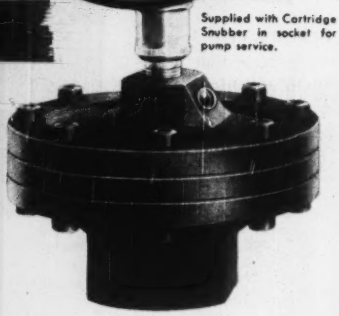
HELICOID Chemical Gage

Standard dials: 0-15, 30, 60, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1500, 2000, 3000. Also 0-30" vac., 15 and vac., 30 and vac., 60 and vac.

Supplied with Cartridge Snubber in socket for pump service.



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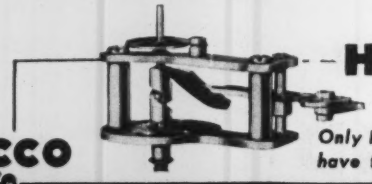
● Here's a chemical gage for any pressure to 3,000 p.s.i. and also for vacuum or compound ranges, and temperatures to 300° F. Particularly suitable for chemicals and other viscous liquids that either corrode or clog a Bourbon tube gage.

One feature of this Chemical Gage is that the diaphragm is made of "TEFLON" which is flexible and resists practically all corrosive chemicals. No fragile metal foils are used. The diaphragm chamber is supplied of any metal most suitable for the service.

Available in the following dial sizes: 4½", 6", or 8½". 1" female N.P.T. bottom connection. Flanged connection also supplied.



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the thermo-plastic diaphragm for longer service life.

Valve bodies for use with the new KEL-F* diaphragms may be cast of corrosion resistant alloys or can be lined with glass, lead, rubber or other impervious linings to suit the operating conditions. Service conditions for the new diaphragms include pressures up to 100 P.S.I. Service temperatures vary according to the material and pressure in the pipe line with a tentative maximum temperature recommendation of 225°F. at the lower pressures. The new diaphragms are not for use under continuous vacuum conditions.

Grade K (KEL-F*) Grinnell-Saunders Valve diaphragms are the result of many months of intensive laboratory research and testing to form polytrifluorochloroethylene into diaphragms which would combine its inertness to chemical attack with the physical properties necessary in diaphragm valve service. The outstanding performance of this thermo-plastic diaphragm in meeting corrosive chemical handling problems assures its welcome by industry.

**Trade name registered by M. W. Kellogg Co.*

New Gauge Measures "Nothing" Better Than Anything

Almost complete nothingness—man's nearest approach to a perfect vacuum—now can be accurately measured by an electronic pressure-gauge 200 times more sensitive than any ever produced before, it has been revealed by scientists at the Westinghouse Research Laboratories, Pittsburgh, Pa. The supersensitive gauge looks like a large radio tube and behaves in a similar manner.

Called an "ion gauge," the new instrument can detect the presence of air in a vacuum where only one air molecule remains out of every 10,000 billion originally present. So rare are air molecules at this pressure that each must travel some 500 miles before striking another. While scientists have gone this far in their quest for a perfect vacuum, until now it has defied measurement.

The gauge was developed by 29-year-old Robert T. Bayard, under the supervision of Dr. Daniel Alpert, head of the inter-atomic physics section of the Westinghouse Research Laboratories.

"This new instrument could prove the key to unlock the door to many new fields of investigation," Dr. Alpert declared. "To study the behavior of very small numbers of molecules, it is necessary to remove practically all of the air molecules originally present in the experimental system. Now that we are able to achieve and measure such ultra-low pressures, we can carry out experi-

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ments which have hitherto been impossible because the particular molecules under study would get lost among the relatively larger number of air molecules. For example, a better understanding of how gases seep through metals should follow as the result of this new instrument."

"To measure the pressure in a vacuum, the gauge is sealed tight to the system," Dr. Alpert said. "Then the power is turned on and electrons from a 'gun' inside the gauge are released, just as in a radio tube.

"When these electrons collide with air molecules in their path, they knock off part of the molecule to create a positively charged particle called an ion. The number of ions formed in this way each second is an accurate measure of the pressure inside the vacuum system. We simply read it from a meter attached to the system. Previous ion gauges were limited in their sensitivity because of false readings produced by x-rays inside the gauge."

For measuring ordinary low pressures, Dr. Alpert explained, scientists use a column of mercury whose height corresponds to the pressure. At atmospheric pressure, the height is about 30-in. Using the new gauge, pressures that would raise a column of mercury only one-thousandth of a billionth of an inch can be detected.

The Westinghouse scientist said that the gauge was developed specifically to aid his group in studying the behavior of atoms, electrons, and radiation in gas-filled tubes, like fluorescent lamps, electronic tubes, and similar devices. Dr. Alpert added, however, that it should find widespread use in other fields.

G-E Generator Still Running After 44 Years Service

A General Electric water wheel generator is still being operated 24 hours a day at Ephraim City, Utah, after 44 years of service. Installed in 1906, the machine was run about 16 hours a day for the first five years. In 1911 it was put into round-the-clock operation, and according to J. H. Jensen, superintendent of the Ephraim City municipal plant, it has been giving almost continuous service ever since.

The only shutdown that the generator experienced was for oiling and cleaning and replacement of a commutator on the exciter in 1922, and for maintenance of the water wheel when it had to be shut down for changing buckets, Jensen said.

Driven by a 32-in.-diameter impulse wheel, the machine has delivered as high as 200 kw for peaks that lasted approximately one hour. The original bearings, coils, and other components of the generator are still in use—no replacements having been required.

In 1909 an overflow flooded the plant with muddy water to a depth of about one foot, but this was not deep enough to bother the generator, which continued to operate. In 1911 the stream deflector on the water wheel broke, allowing the machine to go at a runaway speed for an hour before the operator could get to the plant to shut it down. This happened on a Sunday, and the operator had to come on horseback when he heard of the difficulty. Despite this severe bit of operation, the only damage to the generator was that the external leads were burned.

The machine is rated at 21.6 amperes, 600 rpm, 4000 volts, while the exciter is rated at 40 amps, 600 rpm, 125 volts. A switchboard panel used with the equipment is rated 2300/-4000 volts, 27/5 amps.

Jensen stated that the generator is still giving excellent service, and he expects it will continue to do so for many years to come.

Continued on Page 48

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Designing machines to embody standard components is naturally a cost-saving, time-saving factor . . . but of equal importance — a vital *selling* factor.
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This is one of the major reasons so many manufacturers build-in Winsmith Speed Reducers. They know that any speed reduction needs up to 85 H.P. can be met *at savings* with a fully standardized unit. Looking out for their customers, they know that when parts may be required, they'll always be available . . . on short notice . . . out of stock . . . and like complete units, will slip into position as easily as a nut or bolt, with no alignment problems.
Thus, alongside famous names in bearings, motors and other accessories listed in machinery manufacturers' catalogs, it is common to find Winsmith Speed Reducers. Such products improve performance. Such names help to sell.
Yes, to save in manufacturing costs . . . to help sell more machines . . . Winsmith Speed Reducers belong in the original package. Winsmith's power transmission engineer in your territory welcomes the opportunity to tell you why . . . *more specifically.*
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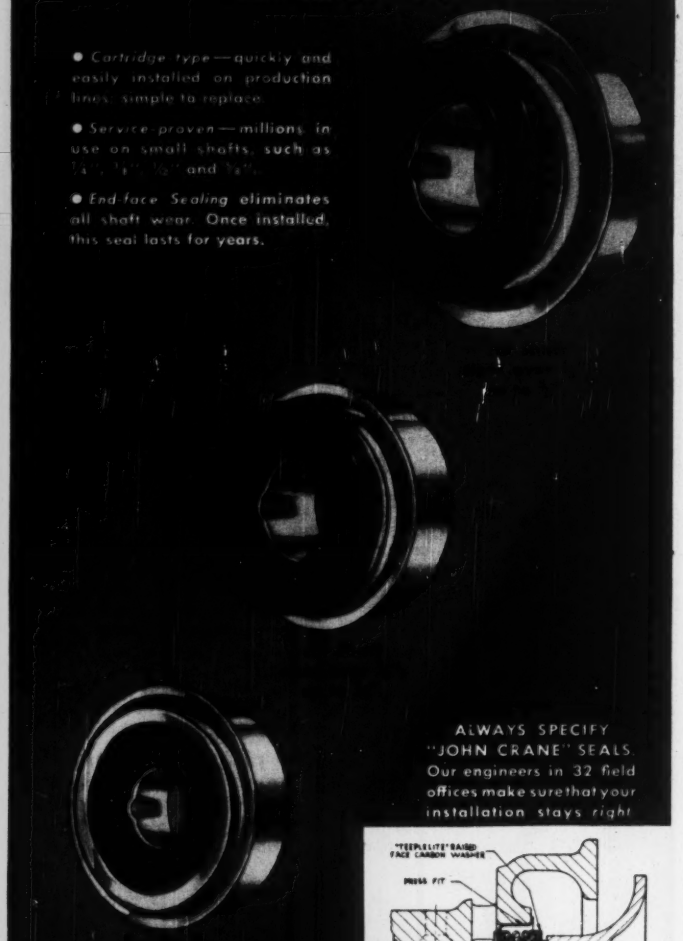

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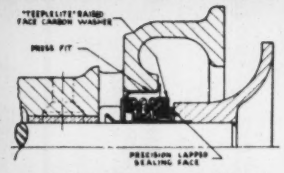

Typical water-pump assembly

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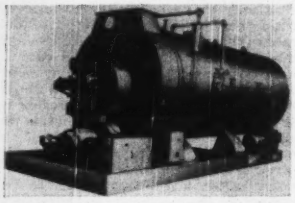
New Cyclotherm Steam Generator

Cyclotherm Corp., Oswego, N. Y., presents a new addition to its automatic line of package type Steam Generators-model #C300. It has the versatility of being fired either with light oil, heavy oil or gas and the combination of gas and oil operation. Available in pressures from 15 to 200 psi. Like all Cyclotherm units, it comes fully equipped with an integral Cyclotherm Burner, fully automatic safety and operating controls, steam trim, valves and other equipment necessary to comprise a complete unit.



Units are fully assembled, piped, wired and test fired for performance prior to shipment. Entire boiler surface is insulated with fibre glass over which is fitted a metal jacket. Units are ready to operate upon arrival, the only connections required are water, steam, fuel and electric.

No stack is required for the function of the Cyclotherm unit. A simple flue vent to conduct the exhaust gases outside the building is sufficient, but local regulations must be observed.

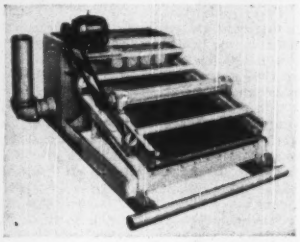
Its patented Cyclonic combustion power represents the first major improvement in Heat Transfer since the inception of Steam Generation.

Other new models now available are C12000, C13800, C10500, C1400, C2100, C1000, C700, and C500. For specification sheets on all above new models write Cyclotherm Corp., Oswego, N. Y.

New Link-Belt Shale Shaker

Link-Belt Co. announces that it is now in production of an entirely new Shale Shaker, Model 49, for the reconditioning of oil well drilling mud.

Embodied in this vibrating shaker are the ideas of practical drillers and mud engineers, plus Link-Belt's own experience of over 20 years in the design, manufacture and application of mud screens.



Actual installations in the field have demonstrated that the new, Model 49 shaker will screen oil-base mud or other high viscosity and heavy muds at larger capacities through smaller openings, and with minimum loss of mud.

Significant features of the new shale shaker are greater strength and rigidity in the screen box; adoption of shear rubber mountings; and a corrosion-resisting coating.

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Greater over-all rigidity and strength have been obtained by fabricating the screen deck as a sturdy separate unit which is welded to the side plates.

The use of rubber mountings in shear as the isolating medium has improved the screening operation by restricting motion at resonance and transmitting less vibration to supports, thereby assuring lower maintenance and longer life.

All metal parts of the shaker are Zincilated. This baked-on corrosion resisting coating penetrates the surface, thereby affording resistance to abrasion and corrosion.

In two years of off-shore drilling under constant exposure to salty atmosphere, and in the laboratory under concentrated corrosive action, this coating has been found superior to any galvanizing or comparable treatment.

Link-Belt furnishes these shale shakers in single or dual units, with or without intake mud boxes, in a range of sizes and modifications to suit any operating conditions, pump capacities, flow line, mud flume arrangements and type of power.

A new 12-page Book No. 2336 illustrates, describes and tabulates shakers of 2, 3 and 4 ft. width by 4 or 5 ft. length of screening deck. It also contains operating instructions and a complete replacement-parts list.

A copy of new Link-Belt Book No. 2336 will be forwarded promptly to any interested reader upon request.

Two New Air Impactools for Nut Running

Ingersoll-Rand Co. of 11 Broadway, New York, announces two new air operated Impactools, the Size 504 for nut running up to $^3/_8$" bolt size, and the Size 510 for nut running up to $^3/_4$" bolt size.

Both tools are the pistol grip type, and are streamlined and well balanced for ease of operation. The large, easy-to-grip reverse caps are deeply grooved so the tools may quickly be reversed even with greasy hands. Palm-fitting pistol grip handles make these tools easy and comfortable to operate over long periods of time.

In designing both of these new tools, emphasis has been placed on scientific muffling to lower operator fatigue and increase morale and safety. To save time on assembly line operations, both tools have a high run-down speed before impacting starts. Small but powerful vane type air motors give all the speed and power needed to handle difficult nut running jobs.

The Size 510 Impactool is a completely new size tool in the company's line of air and electric Impactools. Designed for jobs where it is convenient or necessary to have one hand free to hold the work or pick up the next nut to be run, the Size 510 is the most power-

Continued on Page 49

Hugo Rotary Kiln in the Jacksonville, Florida, paper mill of the **NATIONAL CONTAINER CORPORATION**

they say:

This Lubricant

Following is an extract from a lubrication report made by the plant engineer at the Jacksonville, Florida, Plant.

7' diameter by 300' long lime kiln, supported by five sets of trunnion rollers.

Temperature inside kiln at hot end is approximately 1800° F.

Kiln turns at approximately 1 RPM, trunnions turn at approximately 3 RPM on 7" journals in sleeve bearings lubricated by LUBRIPLATE No. 8.

Since changing to LUBRIPLATE No. 8 two years ago, wear on all bearings and journals has been reduced to a minimum, where formerly a definite problem of lubrication existed.

It is in these unusually severe applications where LUBRIPLATE Lubricants dramatically prove their outstanding qualities. Probably more seemingly impossible lubrication conditions have been satisfactorily met with LUBRIPLATE in the past twenty years than by any other group of lubricants.

In most instances, LUBRIPLATE Lubricants have been introduced to solve a difficult lubrication problem. Their performance is so remarkable that their use is extended throughout the plant. They definitely reduce friction and wear, prevent rust and corrosion and save power.

LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest density greases . . . a product for every lubrication requirement. Let us send you case histories of their use and savings in your industry. Write today.

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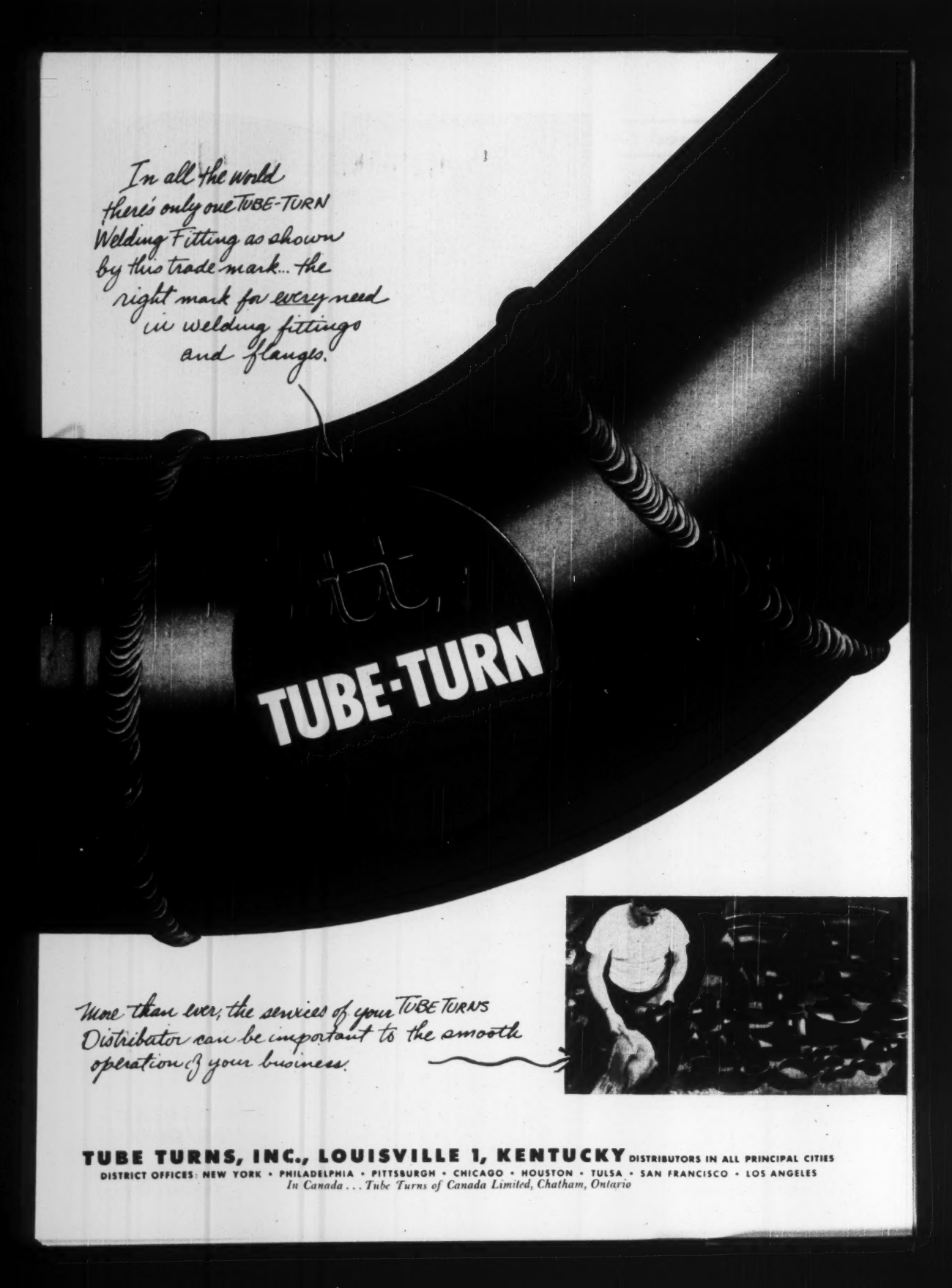
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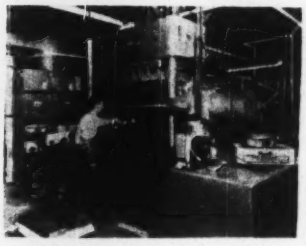
ful Impactool built for one hand operation. It weighs 11-1/4 pounds and measures 10-7/16" long.

The Size 504 Impactool is a completely redesigned tool, 20% more powerful and 65% faster than the old model 504 tool. Due to the extremely effective muffling, it takes 100 new 504 Impactools to equal the noise of one old model 504. The 504 may also be used for multipurpose operation in drilling up to 3/8" diameter or step drilling to 3/4", reaming up to 9/16" diameter, tapping up to 5/8" diameter, driving screws up to 3/16" machine or number 20 wood, hole sawing in sheet metal up to 2" diameter, broken stud and cap screw removal up to 3/8", driving and removing 3/8" studs, masonry drilling up to 5/8", and running wire brushes up to 3/8" shank size. The new Size 504 Impactool weighs 5-3/4 pounds and is 8-9/16" long.

Built-in, automatic lubrication in both the Size 504 and the Size 510 assures continuous top performance and trouble-free operation. Service life of these two new tools has been increased by built-in air strainers to keep rust, scale, dirt, small bits of hose, etc., out of the motors which prevents scoring or undue wear.

Write Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., for information on these two new tools in the complete line of air and electric Impactools to handle nut running up to 4" bolt size.

New Elmes Angle Transfer Molding Press Has Horizontal Rams



High-speed operation, increased productivity, and exceptional ease of control are features of this Angle Transfer Press for plastics molding recently developed by the Elmes Engineering Div. of American Steel Foundries, 1163 Tennessee Avenue, Cincinnati 29, Ohio. This is a standard 300-ton Elmes compression molding press modified to meet special requirements. Equipped with two 50-ton horizontal transfer rams, the press averages 27 to 31 cycles per hour. In addition to specialized quantity production, the press also permits profitable short-run molding, using standard die-sets, for processing a variety of parts simultaneously. Extra large die space, readily accessible front and back, makes die installation easy and permits faster loading of preforms. The press is push-button controlled and has an automatic time cycle.

This press is another example of the work of Elmes engineers in developing special hydraulic equipment to meet customers' individual requirements—presses which perform in one fast, economical cycle work which previously required many complicated, time-consuming, costly operations. For detailed information on Elmes standard hydraulic equipment for the plastics industry, write for Bulletin 52-A. If your needs are special, send detailed information on your requirements and Elmes Engineers will be glad to submit proposals for special presses to meet your needs.

World's Largest Vertical Turbine Pumps Installed for the City of New York's New Hudson River Pumping Plant

The rapid progress being made in the construction of New York City's new emergency pumping plant near Chelsea, 60 miles northwest of New York City, was dramatized by the installation in September of six 20 mgd Peerless 5-stage, close-coupled vertical turbine pumps, each to operate against a head of 600 feet, said to be the largest of their kind in the world. Each of the six pumps is powered by a 2500 h.p. GE vertical synchronous motor. This is the largest h.p. ever applied to the driving of vertical turbine pumps. The tremendous size of these pumps is revealed by the fact that each vertical stainless steel shaft is 4 11/16" in diameter and weighs 820 pounds. Each of the fabricated discharge bases which accommodate the six 2500 h.p. motors weighs 5 tons and each motor weighs over 14 tons.

The enclosed design impellers employed in the big pumps are of the balanced hydraulic thrust type; each impeller weighs 400 lbs. and is held to the shaft by split ring collars and keys. Total weight of complete bowl unit is 6 tons. The general contractor for the pumping station for the Board of Water Supply of New York City is the Tuller Construction Co. and A. J. Dillenbeck, Red Bank, N. J.

New Auto Mat Trimming Press

This Farrel-Birmingham, 125-ton capacity, 84" × 96" hydraulic press is designed for increased efficiency in trimming automobile mats of the currently used larger sizes.

The automatic, cyclical motion of the press platen and the two tables provides time for removal and placement of stock on one table while stock on the other table enters the press, is trimmed, and withdrawn. Press and tables are hydraulically operated by separate, electrically driven pumping

Continued on Page 50

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Information and addresses of registration boards for licensing professional engineers are given, also a list of the 134 accredited engineering curricula of engineering colleges and institutions approved by the Engineering Council for Professional Development.

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units, which, with the oil tank, are mounted on the top crosshead. Inching motion of any one unit is obtained by a selector switch.

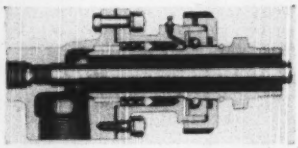
The tables, which operate on antifriction bearing rollers, are surfaced with ground, hardened steel plates. Adjustable deceleration of table movement assures smooth, controlled action.

The reciprocating cylinder has radial ribs extending over the platen area to provide reinforcement against deflection. The upright supports are steel slabs, and other heavy parts of the press, including the ground and polished 18" diameter ram, are of cast Meehanite metal.

Other design features include an arrangement for quickly changing the knife setup, outside packing of all rams, adjustable guides on the moving platen, and safety controls to stop all motion.

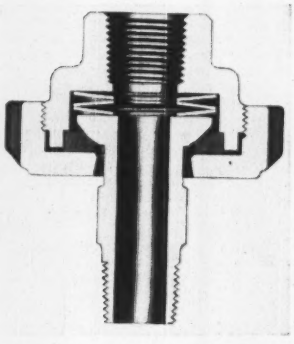
Two Improved Barco Products

Two new products are announced by the Barco Manufacturing Co., 1821J Winnemac Ave., Chicago 40, Ill. They are the improved Barco Revolving Joint, Type IB, and the new Barco Rotary Swivel Joint.



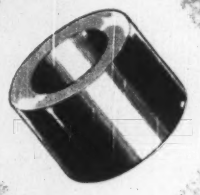
The Barco Revolving Joint, Type IB has been added to the regular line of Barco revolving joints. The new type IB handles 150 lbs. steam pressure whereas the standard Barco Revolving Joint will carry 250 lbs. steam. This new joint has been developed for high speed, continuous rotation with extremely low turning torque. It is designed to provide longer life, less maintenance, less weight and more compact design. It may be serviced in the plant without removing from the roll.

Widely spaced ball bearing supports provide greater strength. It is available with or without syphon and in sizes $\frac{1}{2}$" to 2". Factory tests and preliminary field tests indicate freedom from high torque, leakage and frequent repairs so characterisic of revolving joints in the past.



The new Barco Rotary Swivel Joint supplements the line of standard swivel joints in use for many years. It features low turning torque and perfect sealing under all conditions including hot and cold water or steam and cold water. It has operated successfully on continuous rotation up to

WORKS WHERE OTHERS WON'T



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GRAPHITE METALLIZING CORPORATION
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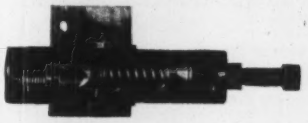
and beyond 30 R.P.M. It is suitable for working steam pressures up to 300 lbs.

The flat wedge angle of the gasket permits free swiveling action with a minimum of friction. Leakage is prevented by a Belleville spring which holds the ball securely in place against the gasket.

The joint is designed to permit angular as well as swivel and rotating motion thus eliminating side strain on piping or on the joint. It is available in sizes $^3/_8$" to 2".

Both the Rotary Swivel Joint and the Revolving Joint, along with other standard Barco flexible joint products, are stocked and sold by leading jobbers everywhere.

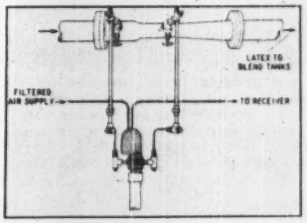
Adjustable Flow Regulators



Waterman Engineering Co. announces the development of an adjustable flow regulator for cylinder speed control. This adjustable regulator gives a constant rate of flow regardless of pressure fluctuations or change in work resistance at any setting within the adjustable range. Adjustable range is 50% of the calibrated flow rate in GPM. It is available for hydraulic systems with operating pressures to 3000 PSI. Line sizes are $^1/_4$", $^3/_8$", $^1/_2$" and $^3/_4$" NPT (dry seal). Maximum controlled flow is 16 GPM.

Seal-Pot Troubles Eliminated in Measuring Latex Flow

A technical report on "Savings Effected at Goodyear Synthetic Rubber Corp. through Control of Latex Flow by d/p Cell" will be of interest to all those whose plant operations involve the measurement of flow of viscous or corrosive fluids. Copies are available on request from The Foxboro Co., 182 Neponset Ave., Foxboro, Mass., industrial instrument engineers, and makers of the d/p Cell (Differential Pressure Pneumatic Transmitter) discussed in the Report.



The Report, which is based on experience in the Goodyear plant at Torrance, Calif., cites three important and specific advantages gained when the d/p Cell was installed on the latex line to the blend tanks, instead of a conventional mercury manometer-type meter. Loss of production time due to instrument trouble was virtually eliminated; man-hours required for maintenance were reduced from 6 per week to 1 per week; and estimated savings, resulting from these two benefits gained, were sufficient to pay for the complete instrumentation in approximately one year.

The details of the Goodyear experience are especially interesting, as the Report discusses the difficulties normally encountered when seal-pots are used in an application of

Continued on Page 52

THOMAS Flexible ALL METAL COUPLINGS
FOR POWER TRANSMISSION REQUIRE NO MAINTENANCE

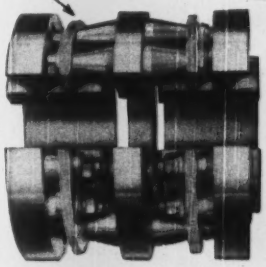
Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years

BACKLASH FRICTION WEAR and CROSS-PULL are eliminated
Lubrication is not required!

PATENTED FLEXIBLE DISCS



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NO MAINTENANCE PROBLEMS.
ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

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this kind, and also describes the routine clean-out procedure which was followed both before and after the d/p Cell Transmitter was installed.

The Foxboro d/p Cell, a compact, mercuryless measuring mechanism operating on the highly accurate force-balance principle is described and illustrated in an Application Data Sheet issued by The Foxboro Co. and accompanying copies of the Technical Report.

Reboilering Program of Great Lakes Fleet Speeds Ore Shipment

The resumption of operation of three veteran vessels after reboilering brings to a total of 115 the vessels of the Great Lakes Fleet now operating with water-tube boilers, according to officials of The Babcock & Wilcox Co.

The reboilered ships are the self-unloading bulk carriers Thunder Bay Quarries and the J. F. Schoellkopf, Jr., owned by the American Steamship Co. and operated by Boland and Cornelius, both reboilered at the Great Lakes Engineering Works, River Rouge, Michigan; and the bulk carrier A. E. Nettleton, owned by the Great Lakes Steamship Co., Inc., and reboilered at the Christy Corp., Sturgeon Bay, Wisconsin.

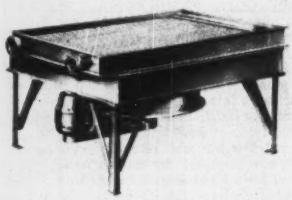
Eighty-five of the 115 vessels using water-tube boilers were equipped by The Babcock & Wilcox Co. Of the three latest vessels to be reboilered, a spokesman for the company said that each ship has been newly equipped with two marine boilers of the single pass header type, fitted with interdeck superheaters, air heaters, side and rear water walls and Detroit Roto stokers.

The boilers for the Thunder Bay Quarries and the J. F. Schoellkopf, Jr., are designed for 330 psi pressure and will operate with uniflow engines, while the boilers for the A. E. Nettleton are designed for 250 psi pressure and will operate with a triple expansion engine.

More than 4,000 vessels of various classes, for all types of service throughout the world, have been equipped with Babcock & Wilcox boilers.

Dry Cooling Equipment

Kansas City, Kansas. . . Three new Dri-Cooler models have been added to the line of dry cooling equipment manufactured by The Marley Co., Inc. Two of the models are small "portable" units, while the other model is designed to fill the need for a medium size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oils, chemical solutions, fluids of refining stages, ammonia or steam condensing, etc.



Models L and M, the portable units, are both forced draft, and have the same cooling capacity. Model L, however, has the fan and tube sections mounted vertically, while Model M (illustrated) has them mounted horizontally. There are seven different sizes of each model. Model JJ units are

If your plant requires
- DIRECT HEATING OF VAPORS
- DIRECT HEATING OF LIQUIDS
- DOWTHERM INDIRECT HEATING
- STEAM GENERATORS
- STEAM SUPERHEATERS
- WASTE HEAT BOILERS

place the selection of the specific type in specialized hands . . . and obtain optimum efficiency.

Petro-Chem Development Company engineers are heating specialists . . . they can supply the whys and wherefores of indirect versus direct heating and the economics of both.

Every day more than 600, oil and gas fired, Petro-Chem Iso-Flow* installations in the petroleum, chemical and allied industries, demonstrate the efficiency of their design and installation.

**Patents issued and pending*

PETRO-CHEM DEVELOPMENT CO., INC.
120 East 41st Street, New York 17, N. Y.
Representatives:
Bethlehem Supply, Tulsa and Houston • Flagg, Brockett & Durgin, Boston • D. D. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholtz, Calif.

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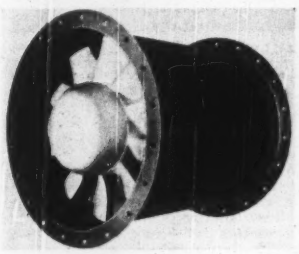
larger in capacity, and are also forced draft, with horizontally mounted sections. The four sizes of this model supplement the heavy-duty application Dri-Coolers, Models J and K.

Standard sections on these units are made of round copper tubes with pressure-bonded aluminum or copper fins, brazed into formed steel pipe headers. They are designed to operate up to 150 psi at 300 F. Framework is made of heavy angle columns braced with angle members. Casing is heavy gauge steel, stiffened with structural angles. Units are completely fabricated and are piece-marked for easy assembly. A corrosion-retarding paint is shop applied. Marley cast aluminum alloy fans are used with a V-belt drive. Fan shafts move on grease-packed bearings in an enclosed bearing housing.

The addition of these three new models gives The Marley Co. a complete line of dry cooling equipment. Dimensions and weights on the new models, as well as rating tables for cooling water, are given in Bulletin DC-50, available from The Marley Co., Inc., Fairfax and Marley Roads, Kansas City 15, Kansas.

Advanced Design Vaneaxial Fans Announced

Propellair Division of Robbins & Myers, Inc. announces the addition of two new vaneaxial type, medium pressure, propeller fans to its famous line of commercial and industrial ventilating equipment. Designed for ductwork applications, vaneaxial fans permit series or straight-through connections for all air-moving requirements. Supplementing aerodynamically-engineered air foil section propellers, the guide vanes prevent swirling; provide a smooth, efficient, axial flow of air. Operating on a low horsepower input, the units possess the ability to work quietly over a wide pressure range.



Air loss ordinarily resulting from turbulence is converted to pressure, surface friction loss in the ductwork is reduced, and operating noise level of the fan is lowered. Steeply pitched blades, on both the propeller and vane, designed with high lift sections at the root, utilize the latest laminar flow airfoils. Pitch and lift sections are reduced as they approach the tip to provide uniform discharge velocity over the entire blade areas. Positioned directly behind the propeller, the vane is mounted independent of the heavy gauge welded steel drum.

Spun aluminum nose and tail cone, providing the functions of streamlining the air flow, are contained within the distance between the two mounting flanges of a 30" duct section. Easily installed in standard 20" and 24" diameter duct systems, the units are equipped with open-ventilated, ball bearing, 40°C rise, standard NEMA foot-mounted motors built by Robbins & Myers, Inc. Adaptable to almost any type of ventilating requirement, Propellair Vaneaxial Fans are

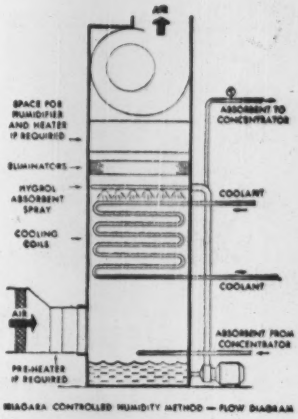
Continued on Page 54

How You Save with the NEW Niagara Method of Air Conditioning

Using "Hygrol" Hygienic Absorbent Liquid

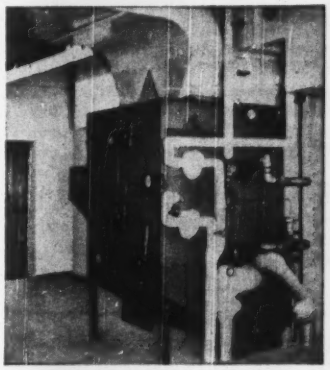
Because it absorbs moisture from the air directly, the new Niagara Controlled Humidity Method uses less, or no, mechanical refrigeration for dehumidifying. You save first costs and installing of heavy machinery. You save space, maintenance expense, power. You get easier, more convenient operation.

Using "Hygrol" hygienic absorbent liquid, this method gives complete control of temperature and relative humidity. Especially, it is a better way to obtain dry air for drying processes, packaging hygroscopic materials, preventing



NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

Food Packaging under Controlled Humidity



Niagara Controlled Humidity Air Conditioner

moisture damage to metals, and obtaining better quality for chemical process products and food products—or in obtaining better results in comfort air conditioning for office or laboratory at lower refrigeration costs.

The diagram shows how filtered air is dehumidified by passing thru a spray of "Hygrol"—a liquid absorbent which removes air-borne moisture. This liquid is hygienic and non-corrosive; it contains no salts or solids to precipitate and cause maintenance troubles. It is continuously re-concentrated at the same rate at which it absorbs moisture, providing always the full capacity of the air conditioner, automatically.

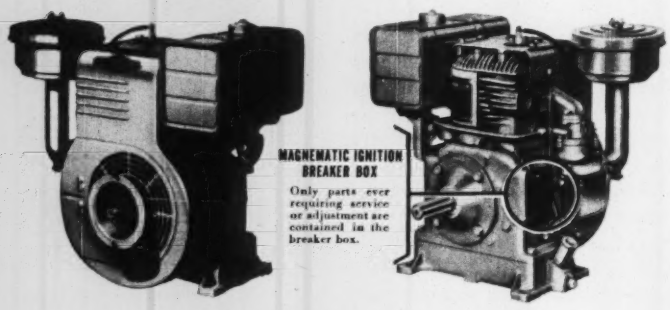
Units provide a range of capacities from 1000 to 20,000 C. F. M. Multiple unit installations are in use successfully. Records of results are available. For further information, write Niagara Blower Co., Dept. ME 405 Lexington Ave., New York 17, N. Y.

ONLY BRIGGS & STRATTON
HAS THE MODERN

Magnematic Ignition

(Patents Pending)

STANDARD EQUIPMENT ON MODELS 9-14-23



A Dependable Spark For Better Engine Performance at ALL SPEEDS

Magnematic Ignition delivers a dependable spark at lower speeds and better engine performance at all speeds.

LONG SPARK PLUG LIFE — magneto output tailored to engine requirements — sparks only on firing stroke — voltage decreases as speed increases, substantially lengthening spark plug life.

AUTOMATIC SPARK ADVANCE — spark is retarded at starting speed and automatically advanced as engine speed increases.

QUICK, EASY STARTING — pull-up cranking with no danger of a "kick" during rope or hand cranking.

SEALED, WATERPROOF COIL — one piece, plastic insulated coil, fully sealed and waterproofed with molded-in high tension lead.

SIMPLE AND DEPENDABLE — no extra gears, bearings or lubrication system.

EASY TO SERVICE — only parts ever requiring service or adjustment accessible by removing breaker-box cover conveniently mounted outside crankcase.

Magnematic Ignition is another exclusive Briggs & Stratton development which is setting new standards of performance for single-cylinder, air-cooled engines.

Write for bulletin giving complete information on Magnematic Ignition and Briggs & Stratton engines.

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BRIGGS & STRATTON
GASOLINE ENGINES

Powered Power
FOR INDUSTRIAL CONSTRUCTION RAILROAD AND FARM EQUIPMENT

World Wide
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In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

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available in two models for characteristic temperature and atmospheric conditions.

Type VCDD Direct Driven airs, constructed with the motor inside the airstream, are suitable for non-hazardous applications, while Type VCS Belt-Driven units are recommended for installations in which corrosive or inflammable fumes, dusts, or vapors must be considered.

A New Yale Hand Chain Hoist

Weighing only one-half as much as conventional hoists of the same capacity, a new Yale hand chain hoist made by the Philadelphia Division, The Yale & Towne Manufacturing Co., enables one man to lift 1000 pounds with less work than it takes to climb an average flight of stairs. For example, the new Yale ½-ton capacity model (weight 37 pounds) has near-impossible 95% efficiency permitting a full load to be easily raised three feet in 20 seconds.

Called the "Load King," the new hoist will succor plants that are feeling the pinch of manpower shortages and the squeeze of high handling costs. It has "carry around" lightness, even in the models designed to lift two tons, and can be moved to the job in a hurry.

Workers, too, will like the "Load King." One man can always operate all models with ease, and its muscle-saving features will leave operators feeling better at the end of a working day even though they've accomplished more work.

Behind the performance figures of the new Yale hoist lay its design innovations. The use of high strength aluminum castings and alloy steel plus fewer parts make it a featherweight without sacrifice of strength or headroom. High speed operation of the "Load King" at unusual efficiencies is due to minimized friction: all rotary shafts have ball bearings, and parts are precision machined.

A new load brake "Synchromatic" provides split-second automatic braking when hoisting or lowering. Balanced and cushioned springs force engagement of a six tooth pawl and a 24-tooth ratchet assuring positive, immediate braking action without any harmful side pressure on bearings. A stabilizer ring speeds brake release for precise inching when lowering a load. This permits the load to be gently eased to the floor or accurately spotted at any vertical distance above it.

Other features of the new Yale hoist include a one-piece housing for support of shafts and bearings—assuring perfect align-

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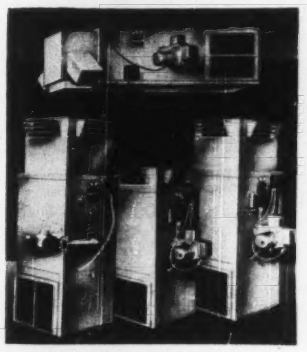
ment for all times—and a new chain of heat-treated alloy steel operating over sheaves of the same material, assuring long usage and minimum wear.

The "Load King" is available in ½, 1, 1½, and 2 ton capacities, with chain provided for a standard lift of eight feet. Other lifts and chain lengths are available. For further information, write to the Philadelphia Division, The Yale & Towne Manufacturing Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.

New Models Added To "Thermobloc" Line



Announcement has just been made by "Thermobloc" Division, Prat-Daniel Corp., East Port Chester, Conn., of the addition of two new, small capacity models to the "Thermobloc" line of self-contained, direct-fired industrial heaters.

The new models, called "ThermoPac" Type, are made in 100,000 and 200,000 BTU/hr output, for either gas or oil firing, with thermostatic control and completely automatic operation. They are fired either by atmospheric gas burners or pressure atomizing type oil burners.

"Thermopacs" may be floor set, wall hung or horizontally suspended. For complete descriptive literature, address "Thermobloc" Div., Prat-Daniel Corp., East Port Chester, Conn.

B & W Launches Super Refractory at Reduced Costs

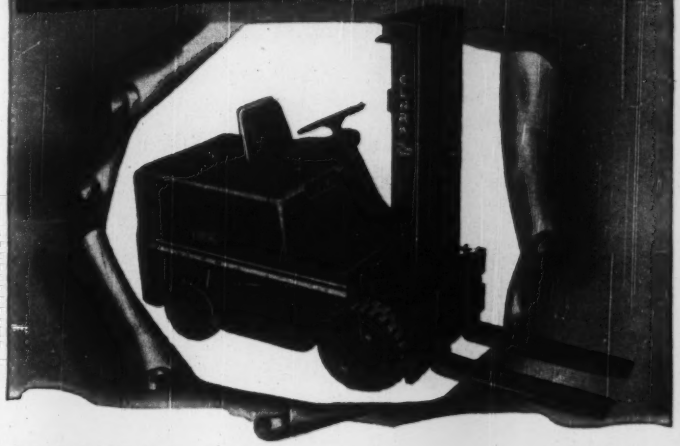
A new super refractory for lining high-temperature furnaces which will meet or surpass the specifications of any such refractories on the market today, but will sell for one-half the usual price in standard firebrick sizes, has been announced by The Babcock & Wilcox Co., 85 Liberty St., New York 6, N. Y.

The new material will be known by the trade name of B&W Allmul, being produced from a base of mullite, a well-known super refractory material. B&W engineers point out that Allmul will not melt until it is heated to more than 3300 F, a point nearly one-third higher than the melting point of steel. When heated to 3000 F a firebrick of the material will support 1000 pounds without deforming and when successively heated to 2550 F and sprayed with cold water a dozen times shows no cracking or chipping. Both of these characteristics are significant because furnaces using this material can be operated at higher and more efficient temperatures for a longer period of time without maintenance interruptions.

Allmul will be produced in quantity at the Augusta, Ga. plant of the Babcock &

Continued on Page 58

DYNATORK DRIVE MAKES A BETTER CLARK CARLOADER!



FASTER! *from forward to reverse* IT DOES MORE WORK!

EASIER! *to operate than your car* IT DOES MORE WORK!

BETTER! *neutral tests prove* IT DOES MORE WORK!

This combination of CARLOADER* and DYNATORK* DRIVE constitutes a forward step of enormous significance to the science of Materials Handling. You'll want to know all about it. A Clark bulletin will bring you the facts in convenient form. Write for it . . . or simply fill in the coupon and mail it.

*Trade Mark Reg. U. S. Pat. Off.

HERE'S A COMBINATION DESTINED TO MAKE MATERIALS HANDLING HISTORY—

• The husky and versatile gas-powered Carloader fork-lift truck of 3,000-, 4,000- and 5,000-lbs.-capacities, has done more than any other one model to establish Mechanized Materials Handling as essential to modern high-speed, low-cost production.

• The revolutionary Dynatork Drive cuts deeply into handling costs *by increasing as much as 20 per cent the amount of work a fork truck can do.* It transmits engine power to the drive wheels by magnetic induction, through an air gap—no clutch, no conventional transmission. It's unique because it does not have to be brought to a stop before reversing.

CLARK ELECTRIC AND GAS POWERED FORK TRUCKS AND INDUSTRIAL TOWING TRACTORS

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Please send: ☐ Literature on Carloader with Dynatork Drive ☐ Movie Digest ☐ Material Handling News

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AUTHORIZED CLARK INDUSTRIAL TRUCK PARTS AND SERVICE STATIONS IN STRATEGIC LOCATIONS

Fig. 3169 single stage, open impeller centrifugal

7 more sizes in this new Centrifugal Line

This new and extremely successful line of centrifugals is now available in 10 sizes. You can now take advantage of the efficiency of this new design to fill your pumping needs in a wide variety of applications.

APPLICATIONS

Goulds designed the Fig. 3169 especially for general water service, irrigation, Slurries, circulation, transfer and factory wastes. It also gives excellent service in air conditioning, plumbing, heating, processing and related applications.

ADVANTAGES

The most important advantage of these pumps is their efficient, modern design. Simple construction, light weight and compact size give you reasonable price and unusually good service over a long period of time.

CAPACITIES

Fig. 3169 is made in 10 sizes for both motor and belt drives. Capacities to 1000 G.P.M. with heads to 180 ft., depending on capacity.

For more information call or write Pump Headquarters or your nearest Goulds dealer. Ask for Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

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Wilcox Refractories Division and, explaining the relatively low price, A. M. Kohler, vice president in charge of the division said, "Most of the super refractories of this nature are produced in small volume, so that mass production cost savings cannot be made. Our study of the market led us to believe that a lower price would encourage volume sales, consequently, we developed straight-line production methods to affect the lowest manufacturing costs." He also explained that because the material would have application to many war production processes, the company was anxious to make it widely available at this time.

The new material will be used by industries such as steel, non-ferrous metals, chemicals, glass and other ceramics where it should enable savings not only in original cost but in furnace maintenance by reducing periodic repairs and lost production time due to shutdowns, the company pointed out. B&W Allmul will be manufactured principally in the form of firebrick, but will also be available in the form of grain and ramming mixes.

Liquid Sample Cooler Offered by Worthington

A liquid Sample Cooler for cooling boiler and boiler feedwater samples has been announced by Worthington Pump & Machinery Corp.

Suitable for cooling samples required for controlling chemical and refinery processes and for general laboratory use, it is of stainless steel construction. It is a shell and tubular coil type heat exchanger of all welded construction designed so that all connections are external to both cooling coil and jackets.

The sample cooler features the "Counterflow" principle making possible the cooling of liquid samples to temperatures approaching those of the inlet cooling media.

Designed for 1500 psi and temperatures of 600 degrees F. on the cooling coil side, and 150 psi on the stainless jacket side, it has an outside diameter of $3^{3}/_{8}$" and an overall length of $11^{1}/_{4}$" and is made in capacities of $^{1}/_{4}$ and $^{1}/_{2}$ gallons per minute.

New York's Newest Skyscraper Will Be Completely Air Conditioned

New York's newest skyscraper, the Massachusetts Mutual Life Insurance Co. Building, will be completely air conditioned by means of a rooftop installation of the new steam-operated absorption machine, now being produced in higher capacities than ever before, it was announced by Carrier Corp.

Four of the recently developed refrigeration machines, located atop the 27th floor of the building now rising at 600 Fifth Avenue, will employ district steam taken from the street mains to produce chilled water for the air conditioning system. All outside rooms will be served by the Conduit Weathermaster System.

Four other new Manhattan skyscrapers, including the huge United Nations Secretariat Building, have installed this space-saving Carrier conduit system within the last year, using centrifugal machines for refrigeration.

The Massachusetts Mutual installation will be self sufficient so far as any continuing water supply from outside sources is concerned. Make-up water for the cooling tower, replacing losses due to evaporation, will be recovered in more than sufficient quantity from the steam condensate.

Each of the four absorption machines for the new building will have a capacity of 275 tons. These are the first units to be produced with a capacity beyond 200 tons, and similar models will range up to 350 tons.

Carrier engineers reported that material savings in initial costs were made possible by

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the rooftop installation. In addition to space savings through elimination of the usual machine room in the basement, location of the refrigeration units on the same level as the cooling tower will make it unnecessary to install heavy piping for the pumping of condenser water from basement to roof.

The absorption units use only plain water as a refrigerant. Temperature is lowered through the flash evaporation of water sprayed into a high vacuum. Lithium bromide is employed as an absorbent, and can be used repeatedly without loss. When saturated, the water is boiled out of the solution by the use of steam, and the salt is pumped back into the absorber chamber. Thus a continuous cycle is established.

The machines themselves are light in weight, compact and all but vibrationless. And their operation provides a balance in steam loads for summer cooling and winter heating. The New York Steam Corp. estimated it would supply approximately 34,600,000 pounds of steam annually for the new building.

In the operation of the Conduit Weathermaster System, more than 2.6 miles of conduit will carry conditioned air under pressure to a total of 849 outlets, located under each window. Occupants of these offices will have individual control over their own room climate.

Interior areas of the building, particularly the first seven floors, or block section, will use the conventional overhead duct system. The air conditioning load will be divided almost equally between duct distribution and the Weathermaster system, with the latter taking over most of the job in the tower section, from the 8th to the 27th floors.

The new Fifth Avenue structure, on the former site of the Collegiate Church of St. Nicholas, between 48th and 49th streets, will have underground passages leading to other buildings in the Radio City group. It is scheduled for completion early in 1951.

Air conditioning engineers for the project are Jaros, Baum & Bolles. The Turner Construction Co. is the general contractor and Carson & Lundin are the architects.

University of North Carolina Installs 10,000 KW Worthington Turbine Generator

To heat campus buildings, and supply steam for cooking, the University of North Carolina, Chapel Hill, N. C., will install a 10,000 KW 80% power factor, 3-phase 60-cycle 6900-volt Worthington Pump & Machinery Corp. turbine generator.

The turbine is to take steam at 400 lb. pressure, 750 degrees F. total temperature, and to exhaust a 2½" absolute. It is a bleeder type turbine and is designed to bleed any or all steam up to approximately 178,000 pounds per hour at 25 pounds pressure. Shipment of the all-Worthington turbine generator will be made in April, 1951.

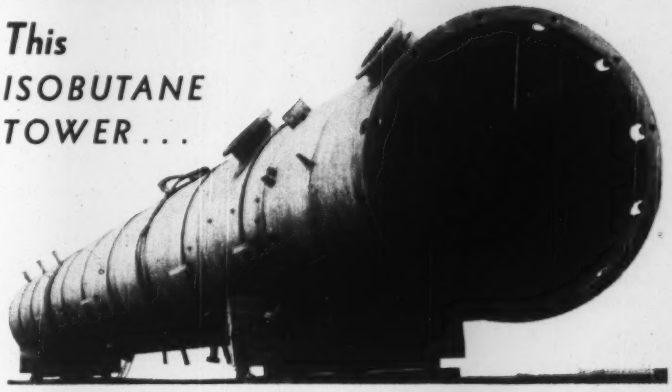
To Air Condition America's Oldest Department Store

Hager's believed to be the oldest Department Store in the United States, on the same location and continuously operated under the same family name since 1821 at Lancaster, Pa., will be scientifically air conditioned to provide greater shopping comfort and better working conditions for its employees, it has been announced.

John R. Hertzler, Vice-President and General Sales Manager of York Corp., says that his firm is furnishing a 150 HP V/W compressor water cooling system through the Lehigh Engineering Co. of Bethlehem, Pa., to provide air conditioning for five selling

Continued on Page 58

Why WISCONSIN
FOUR-CYLINDER
Air-Cooled ENGINES
ARE ALL V-TYPE
V VE-4
15 to 21.5 hp.
V VF-4
17.5 to 25 hp.
V VP-4
26.8 to 31 hp.
1. V-type design provides a more compact power package for easier, more adaptable installation on original equipment.
2. V-type design means lighter weight, adding to ease of handling and mobility.
3. V-type design provides most efficient air cooling — the air blast travels only half as far as required for a 4-cylinder "straight-in-line" engine.
4. More uniform cooling of V-type engines assures more economical and smoother engine performance; lower maintenance cost; longer engine life.
5. V-type cylinders are cast in pairs, 2 cylinders to a block, thus greatly reducing replacement cost if and when that should be necessary and simplifying servicing.
Wisconsin V-type 4-cylinder design is typical of the advanced engineering know-how that goes into all Wisconsin Engines . . . 4-cycle single cylinder, 2-cylinder and 4-cylinder models, in a complete power range from 3 to 30 hp. Write for detailed data.
MOST H.P. HOURS
WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 16 WISCONSIN



fabricated by DOWNINGTOWN

The above pictured unit is 108" I.D. x 126' 0" long on the straight, weighing approximately 70 tons. The vessel was constructed of Carbon Steel to the requirements of the API-ASME Code; all seams being X-RAYED at their intersections. This vessel was loaded on two 50' 0" and one 42' 0" flat R.R. cars.

DOWNINGTOWN Engineers and Technicians have given considerable study to many factors and processes of Plate Fabrication. Consequently, we have arrived at conclusions which we firmly believe assure a quality job.

Your inquiries for pressure vessels of Nickel Clad, Stainless, Stainless Clad, Carbon Steel, are solicited. Another important factor of our business is the design and fabrication of Heat Exchanger Equipment.

HEAT EXCHANGERS • WELDED AND RIVETED PRODUCTS

Downingtown Iron Works, Downingtown, Pa.

NEW YORK OFFICE — 30 CHURCH STREET

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NEEDS NO PLUMBING OR EXHAUST DUCTS

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Get top-quality copies in the quantity you want. Get them inexpensively and *on time*. Get a Bruning Whiteprinter! For full details, send coupon or write *Charles Bruning Company, Inc., Dept. B-100, 100 Reade St., New York.*

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floors of this historic store, totalling 742,000 cubic feet.

Christopher Hager founded Hager's store in Lancaster in 1821 and served as its head until 1848, the year he was named President of the Farmers' Bank of Lancaster. He is credited with starting the Fulton Opera House in 1852. He also was a trustee of Franklin and Marshall College for a number of years.

Hertzler pointed out that the trend is definitely towards extension of the use of air conditioning in department stores. "Department store owners and operators," he said, "have found that it not only increases business and betters working conditions for store employees in basement and first floor sales areas but also year-round air conditioning can well be justified throughout the building to provide filtered, clear air to the store, reducing stock spoilage and building renovation, painting and cleaning costs."

Flux Removal Problem Eliminated by G.E. Inert Arc Welding Process

The Day Co. of Minneapolis, fabricators of steel and alloy products for food and chemical industries, recently fabricated aluminum salt bins using the General Electric inert-arc welding process without the use of flux or special cleaning.

The salt bins have an over-all height of 10 feet 3 inches, with diameters ranging from six to eight feet. They are fabricated from 61S-T6 aluminum of various gages through $\frac{1}{4}$ inch. No preheat or special cleaning was used, and because of the bulkiness of the bins, many welds were made in the vertical-up and vertical-down positions.

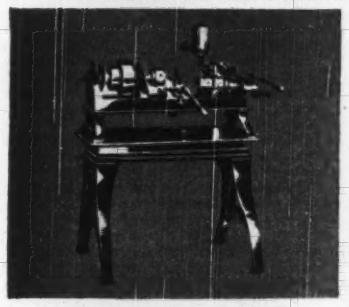
According to Verner Holstrom, superintendent of the Day Co., the inert-arc welder eliminated the expensive flux removal problem and nullified corrosive action due to entrapped flux. The inert-arc process is the outcome of fundamental research in the General Electric welding laboratories. Welding aluminum without flux is one of the applications of the process.

29 Miles of Tubing Made for Boilers of Round-the-World Ships

More than 29 miles of tubing were manufactured in the Beaver Falls, Pa., plant of The Babcock & Wilcox Tube Co. for boilers of the three new round-the-world ships of the American President Lines. This represents 211 tons of carbon and alloy, hot-finished and cold-drawn seamless steel tubing. The Babcock and Wilcox Tube Co. is one of the leading producers of seamless and welded,

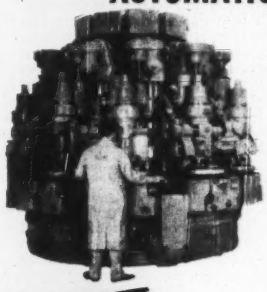
Yesterday

MECHANIZATION



Today

AUTOMATION



Always STUART CUTTING FLUIDS

for Higher Production

HIGHER SPEEDS! Greater feeds! Closer tolerances! Better finishes! New materials! Automatic operation! Lower costs! More production!

Those are the challenges D. A. Stuart Oil Co. has been helping the metal-working industry meet since 1865. ***And, every moment of progress has spotlighted the critical importance of cutting fluids.*** You will never get the production that is built into modern machine tools without the *best* cutting fluid for the job *properly applied.* WRITE FOR "CUTTING FLUID FACTS."

AT THE METAL SHOW Booth No. 328

D. A. Stuart Oil Co.

2741 S. Troy St., Chicago 23, Ill.

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carbon, alloy and stainless steel specialty tubing, with plants at Beaver Falls, Pa., and Alliance, Ohio.

The first of the ships, the President Jackson, was launched on June 27, at the Camden, N. J., yards of the New York Shipbuilding Corp., and her sister ships, the Presidents Hayes and Adams, will follow this year.

There will be two boilers in each ship to supply the 107,000 pounds of steam per hour required to drive the vessel at her cruising speed of 19 knots. B & W engineers point out that, in order to save valuable space, the boilers are designed to incorporate all the efficiencies of land based boilers of the same capacity, but to occupy only about one-third the space.

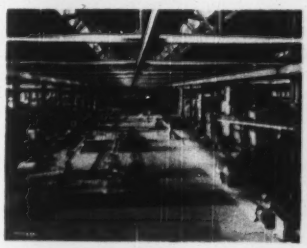
The tubing was shipped to the Alliance and Barberton works of The Babcock & Wilcox Co. for fabrication and eventual shipment to Camden for installation in the ships.

Fifty-three tons of tubes, $8^{3}/_{4}$" O.D. by $^{11}/_{16}$" wall, were for the headers; $14^{1}/_{2}$ tons of tubes, $4^{1}/_{2}$" O.D. by .340" wall, were for the downcomers and risers; and the balance were for the water walls, superheaters and generators.

Some 107,751 feet of $1^{1}/_{4}$" O.D. by .105" wall cold-drawn seamless carbon steel tubing were for the boilers and generators. Superheater tubing accounted for 25,674 feet of $1^{1}/_{4}$" O.D. by .135" wall cold-drawn carbon steel tubing and an additional 6,527 feet of B & W Croloy $2^{1}/_{4}$" tubing, an alloy developed by The Babcock & Wilcox Tube Co., for high-temperature applications.

New Test Laboratory at Peerless Pump Indianapolis Works Marked by Many New Techniques and Equipment

Marked by many new innovations in advanced test-laboratory techniques and equipment to insure peak product quality and to guarantee matching or exceeding customer requirements of pump performance, Peerless Pump Division of the Food Machinery & Chemical Corp. has announced the completion of a new pump testing laboratory at its Indianapolis Works, Indianapolis, Ind. The installation, finished this month, involves a consideration of over a quarter million dollars and establishes a completely new set of standards in pump testing procedures in this field of product manufacture. The laboratory occupies over 7000 square feet of floor area and includes a total of eight pump stations. Both high and low voltage equipment is available, making use of motors up to 1000 h.p. in size.

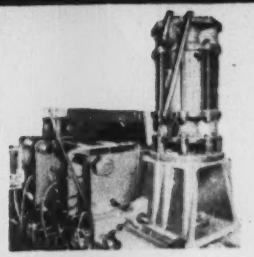


The Peerless test laboratory is designed for a capacity of over a half million gallons of water, believed to be the largest in the United States.

Pumps are tested to obtain their complete performance characteristics, to observe their operation, and to compare results in the laboratory, with calculated and design performance data. This requires measurement

Continued on Page 60

Ledeen cylinders improve the job



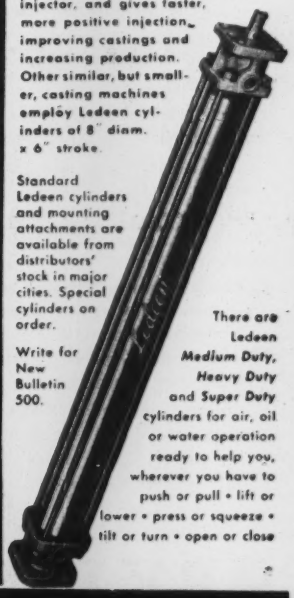
CYLINDER SPEEDS DIE CAST PRODUCTION CYCLE

An increased rate of die cast production and a definite product improvement are made possible by the use of this standard 12" diam. x 8" stroke Ledeen *Super Duty* Cylinder, operating from plant air supply of 100 P.S.I.

Cylinder supplies injection power to force molten metal into the die. It replaces the usual screw-type injector, and gives faster, more positive injection, improving castings and increasing production. Other similar, but smaller, casting machines employ Ledeen cylinders of 8" diam. x 6" stroke.

Standard Ledeen cylinders and mounting attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for New Bulletin 500.



There are Ledeen *Medium Duty, Heavy Duty* and *Super Duty* cylinders for air, oil or water operation ready to help you, wherever you have to push or pull • lift or lower • press or squeeze • tilt or turn • open or close

Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders •

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How to keep Line "FEATHERS" out of your hair !

It was a clean, sharp line till it had to be erased. But when it was re-inked, brother how it feathered and "blobbed"!

Feathering lines are one of the things you *don't* have to worry about with Arkwright Tracing Cloth. Even erased surfaces will take a neat, sharp line. What's more, you'll never find pinholes, thick threads or other imperfections in Arkwright cloth. You'll never have to fear that your drawings will discolor, go brittle or become opaque with age. A drawing on Arkwright Tracing Cloth will yield clean, clear blue-prints years after you make it.

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ARKWRIGHT *Tracing Cloths*

AMERICA'S STANDARD FOR OVER 25 YEARS

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of the amount of water or capacity handled by the pump, the head against which the pump is operating, the power input to the pump and the exact speed of operation during measurements of the input and output factors. By conventional hydraulic formulae efficiencies can be computed; and results with liquids other than water can be calculated, if required. A pump laboratory requires a large water supply so that accurate test readings can be obtained without air being entrained in the water and to avoid over-heating of the water due to recirculation.

In order to insure ample water for testing of several units at the same time and also to provide sufficient volume for large capacity pumps, a test pit 30 feet wide by 192 feet long and 12 feet deep was constructed. At one end of this rectangular pit a round pit 10 feet in diameter and 40 feet deep makes it possible to test vertical pumps. A dividing wall in the center of the large rectangular pit permits drainage of half of the pit for cleaning without disrupting testing in the other half, as well as for possible calibration of large meters by displacement. Based on a 20% recirculation of water, the pit is of ample size to test pumps up to 86,000 GPM capacity.

There are several unique refinements in the hydraulic apparatus for greatest accuracy in pump testing. For example, venturi meters of the Simplex valve and meter type have been installed and insure accurate measurements of capacities within half of 1%. Mercury manometers with scales calibrated directly in GPM for each size venturi tube guarantee maximum accuracy in capacity measurements and reduce to a minimum the time required to make each test. Each discharge pipe assembly has a straight piece of pipe of at least ten pipe diameters, and more on the smaller sizes, installed between pump nozzle and venturi meter. In addition, each discharge pipe contains a pair of straightening vanes three times the pipe diameter in length and welded in the pipe 12" above the venturi meter. The smaller venturi meters, 12" and below, are arranged for manifolding in pairs, and these pipe assemblies have an additional honeycomb type straightening section of at least one pipe length installed at the upper end, joining the manifold. By using these straightening devices and a long straight run of pipe prior to entrance into the venturi section, much more accurate readings in capacity can be made in the laboratory than is normally possible in a field test with its limitations due to piping restrictions and turbulence due to fittings and insufficient length of straight pipe before a measuring device.

Head measurements up to 100 feet can be measured with a mercury column calibrated in feet of water to facilitate calculations and eliminate errors. Beyond 100 feet head calibrated Bourdon tube type gauges are used to measure the discharge pressure in pounds per square inch up to any pressure required. The Bourdon tube test gauges are regularly checked on a dead weight gauge tester to insure highest accuracy of head measurements. Mercury manometers are used on the suction side of the horizontal pumps to obtain direct readings of the suction lift. From these suction lift readings and discharge heads and any necessary correction for velocity head, the total head of the pump is easily computed.

One of the outstanding features of the new Peerless hydraulic laboratory is the extremely accurate horizontal cradle mounted dynamometer equipment supplied by the General Electric Co. These direct current dynamometers are controlled by amplidynes with electronic pre-amplifiers. The Peerless installation is the first hydraulic pump labora-

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tory in America to use this type of control. A 10 HP, 25 HP, 75 HP, 200 HP and 450 HP dynamometer with operating speeds up to 4500 RPM provide a wide selection of sizes, so that deflection on the Toledo-No Springs—dynamometer scales will give the highest accuracy of readings possible. Since the pump capacity varies directly as the speed, the head as the square of the speed and the horsepower as the cube of the speed, even small speed fluctuations during a test greatly increases the errors between capacity, head and horsepower readings.

Prior to purchasing the dynamometers finally installed, the engineers of Peerless Pump Division studied many different methods now being used to properly control the speed on pump drives. Several pump testing laboratories have improved on the old manually adjusted DC dynamometer commonly used in the pump industry by using a differential gearing mechanism which compares the speed of the pump on test with that of a constant reference. This method of constant speed control is quite accurate but carries with it a certain amount of inertia and therefore Peerless engineers decided on a system employing electronic speed regulators which maintain the speed within less than 1/2% of the pre-set pump speed, even following severe torque fluctuations.

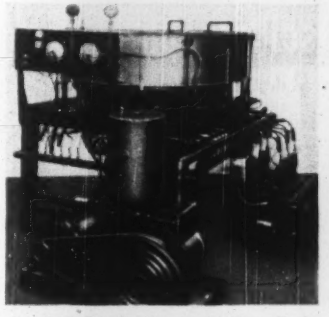
The switch gear and motor-generator equipment is housed in a separate enclosed fireproof, dust-proof room. The motor-generator sets are designed to produce DC power for the dynamometers which are electronically controlled in conjunction with amplidynes to insure constant and accurate speed control. Briefly, this regulating system consists of a small alnico generator direct connected to the dynamometer which puts out a voltage signal directly proportional to motor or pump speed. This signal is fed into an electronic pre-amplifier, which regulates the voltage on an amplidyne generator controlling the main generator field, thus regulating dynamometer speed by controlling the main generator voltage. With this equipment it is possible to set any desired speed at the dynamometer control desk and make a complete set of head, capacity, and horsepower readings at this given speed without further adjustment of any controls on the generator or the DC driver. Since the speed is held constant by automatic devices, the capacity is read directly in GPM and the head is read either in feet of water or is easily computed from pressure gauge readings, no further calculations are necessary. Thus it is possible to observe immediately all the operating characteristics of the pump under test. In addition to this ease of testing, the fact that practically no fluctuations of the operating speed exist gives much greater accuracies throughout the test.

At each dynamometer station there is a master control desk from which the test engineer can start and stop the machines and adjust the speed. Also, as part of the control desk, there is electric chronotachometer equipment which includes an approximate RPM meter, a high accuracy revolution counter and electric timer which enables the recording of average pump speed over a period of time to very close values. With this highly accurate RPM reading and the dynamometer torque reading on the Toledo scale, the horsepower can easily be figured and assures an accurate calculation of the efficiency of the pumping unit.

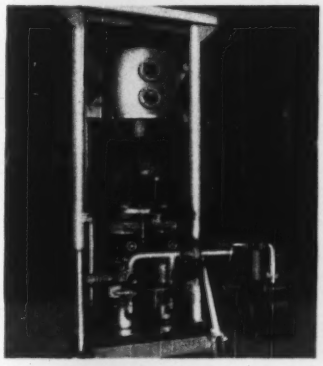
It always has been standard practice with Peerless Pump Div. and the Dayton-Dowd Co., which was acquired by Peerless several years ago, to make complete running tests of all engineered horizontal pumps prior to ship-

Continued on Page 62

First Thought
FOR VACUUM!



Eisler Radio Tube Machine showing Kinney Single Stage Pump used for initial pump-down and for backing Eisler Pump. The vacuum exhausting process is fast, sure, and extremely complete . . . making possible longer-lived, better-performing tubes.



National Research Corporation high vacuum metallurgical furnace. Kinney Pump used for roughing and for backing diffusion pumps. In high vacuum furnaces metals like Titanium, Zirconium and Molybdenum are being cast or treated in the pure gas-free state. These vacuum-processed metals display new qualities of ductility and conductivity . . . new advantages made possible by Kinney-created low absolute pressures.

When the job calls for vacuum processing, keep *Kinney High Vacuum Pumps* in mind. Thousands and thousands of successful installations prove beyond doubt that it's wise to make Kinney Pumps your first thought for vacuum!

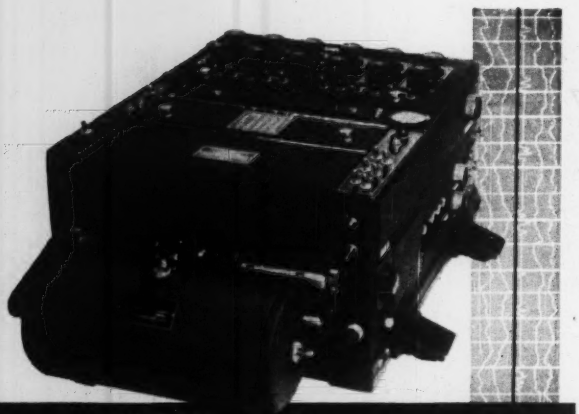
Why do so many modern vacuum processing systems employ Kinney Vacuum Pumps? Because these Pumps save processing time, because they conserve operating costs, and because they can be trusted on the job. If you want fast pump-down and minimum equipment "down-time", the Kinney Pump is the pump you need. Write for Bulletin V45, the complete story on Kinney High Vacuum Pumps and Equipment.

KINNEY MANUFACTURING CO., 3582 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Foreign Representatives: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland . . . C.I.R.E., Piazza Cavour 25, Rome, Italy.

Making old things better • Making new things possible

KINNEY Vacuum Pumps



the *NEW* S-8 Oscillograph

Here, in a versatile instrument of advanced design, are all the things you need for complete oscillographic recording. The Hathaway Type S-8 Oscillograph, which has long been the standard of oscillographic recording, has been improved to meet the rapidly expanding demands of modern research. Whether your measurement problems are simple or complex, the NEW Type S-8 Oscillograph has the inherent capabilities necessary to measure vibration, pressure, acceleration, and strain with new ease and accuracy.

The newest features include:

QUICK-CHANGE TRANSMISSION *fully enclosed with gears running in oil* **to provide instantaneous selection of 16 record speeds over the range of 120:1**

CHART TRAVEL INDICATOR provides continuous indication of chart motion. Operator knows instantly by flashing lamp if anything should happen to interfere with chart motion

FULL-RESILIENT MOUNTING FOR MOTOR AND TRANSMISSION isolates all possible vibration and makes possible the use of modern super-sensitive galvanometers

NEW GALVANOMETER STAGE accommodates *all* Hathaway galvanometer for recording milliamperes, microamperes, or watts

NEW RECORD-LENGTH CONTROL AND NUMBERING SYSTEM designed for long, trouble-free service under all kinds of ambient conditions

All the other valuable features are retained, such as

PRECISION TUNING-FORK-CONTROLLED TIMING SYSTEM produces either 1/10-second or 1/100-second time lines across sheet

WIDE RANGE OF GALVANOMETER TYPES AND CHARACTERISTICS provide for almost any recording requirements. Natural frequencies to 10,000 cps. Sensitivities to 50,000 mm per ma, single and polyphase watts

DAYLIGHT LOADING AND UNLOADING RECORDS TO 200 FT. IN LENGTH, width to 10 inches

SIMULTANEOUS VIEWING AND RECORDING

AUTOMATIC BRILLIANCY CONTROL

12 TO 92 ELEMENTS

Whatever your needs may be, investigate the NEW Type S-8 Oscillograph and its 170 types of galvanometers — the most versatile equipment in existence for general-purpose applications.

WRITE FOR BULLETIN 2B1-K

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

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ment to insure their accurate and reliable operation in the field. In addition, much testing has been done and will continue to be done in the future in developing new and still better pumping equipment for Peerless customers. As designs become more perfected, permitting further improvements in pumping equipment, it is also necessary to have more accurate testing devices to measure each fractional percent of any improvement. The Peerless Pump Division with its complete and accurate equipment in their Indianapolis test laboratory will be able to continue to forge ahead as a leader in the design and manufacture of better pumping units for their customers.

For New Type Supercalender Drive

A new drive for installation on a 72-inch-wide supercalender which will produce a double finish on waxed paper at pushbutton-controlled speeds up to 1600 feet per minute, with a threading speed of 50 feet per minute, has been ordered from Westinghouse Electric Corp. by the Appleton Machine Co., Appleton, Wisconsin. The supercalender will be installed at the Peshtigo, Wisconsin mill of the Badger Paper Mills, Inc.

Of particular interest is the motorized wind-up stand used with this supercalender. A booster generator provides "inch" operation of this section, stalled tension, IR drop compensation and inertia compensation. A Rototrol rotating regulator is used as a constant horsepower regulator on the wind stand motor. In conjunction with the booster generator, it provides tapered tension, which produces a tightly wrapped core and a softer, more uniform roll. The roll diameter range is from 6" minimum to 32" maximum.

New Demagnetizer Announced by General Electric Company

An improved design of demagnetizing coil was recently announced by the Special Products Division of the General Electric Co. Developed by the company's General Engineering and Consulting Laboratory, the instrument is highly effective in demagnetizing materials and stabilizing magnetic flux.

Engineers pointed out any unshielded magnetically soft material, including forms of iron and steel, can be demagnetized by this instrument. They said the device can be used to eliminate undesirable magnetic flux from tools, drills, punches, small arms, and any machined parts that may have become magnetized. Often drills and cutting tools which are magnetized will collect chips, heat up, and become dull much more quickly than when demagnetized, engineers continued, adding that particles of metal clinging to magnetized machined parts may cause severe wear and inaccurate performance.

The demagnetizer is also useful in equalizing and stabilizing magnetic flux in permanent-magnet assemblies that are used in electrical instruments and control devices. In general, permanent magnets are magnetized to a flux density higher than that required in the finished product. The demagnetizer is capable of reducing the flux density and stabilizing it at the desired value.

The G-E demagnetizer is shipped complete and ready for use. It consists of an air-core coil built in a frame which can be mounted on any table or bench. The coil is rated at 115 volts, 60 cycles, and is equipped with switch, pilot lamp, and a flexible lead fitted with a standard plug. It has a rectangular opening $4^1/_2$" × $8^1/_2$" to accommodate stock up to 8 inches wide. The coil axis being horizontal, mass production demagnetizing may be accomplished by

• Keep Informed

passing a non-metallic conveyor belt through the instrument parallel to the coil axis. In this manner parts can be demagnetized continuously. Pieces of considerable length can be demagnetized, or several small pieces can be demagnetized simultaneously, provided they are not in a metal container and are not in sufficient contact to cause shielding of any of the pieces. Grease, dirt, scale, or rust does not affect the demagnetization process.

• BUSINESS CHANGES

Permutit Acquires American Cyanamid Ion Exchangers

The Permutit Co. of New York announces that it has acquired from the American Cyanamid Co. its ion exchange business and the trademark "Ionac." These materials will be manufactured and distributed by Permutit's subsidiary, The American Zeolite Corp.

New Chiksan Appointments

Clifford B. Ives & Co., 105 Forrest Ave., Narberth, Pa., has been appointed representatives for Chiksan Co. of Brea, California, in the Philadelphia territory. The Rhodes Controls Co., 11 East 21st St., Baltimore, Md., has been appointed to represent Chiksan in the Baltimore area. Both of these territories were covered previously by Chiksan's eastern headquarters in Newark, N. J.

Newly Named A-C Representatives

Four newly named sales representatives to Allis-Chalmers general machinery division offices are Donald H. McIntosh and Kenneth V. Knudsen to Chicago; Delpherd H. Verhein to Milwaukee, and Daniel Boland to Davenport, Iowa.

McIntosh has been with Allis-Chalmers since 1942 and was formerly supervisor of the special applications group in the company's substation section. He is an electrical engineering graduate of Iowa State College.

Knudsen came to Allis-Chalmers in 1949 following his graduation from Illinois Institute of Technology with an electrical engineering degree.

Verhein holds an electrical engineering degree from Marquette University and came to Allis-Chalmers in 1948 following his graduation.

Boland is a 1948 mechanical engineering graduate of Michigan Tech and joined Allis-Chalmers in 1949.

All four engineers have completed Allis-Chalmers' graduate training course. McIntosh is a member of the AIEE and Verhein is an associate of that society. Boland is a member of the ASME.

• LATEST CATALOGS

Goulds New Self-Priming Pump

Complete information on the new self-priming centrifugal pump line is now available from Goulds Pumps, Inc., Seneca Falls, N. Y.

The pumps are of a new design that eliminates valves and yet gives efficiency comparable to standard centrifugal pumps.

These self-priming pumps are made in sizes ranging from 1/4 H. P. to 5 H. P. with both open and closed impellers. Capacities to 120 G.P.M. and heads to 135 feet depending upon capacity. They can handle suction lifts up to 25 feet.

Write Goulds Pumps, Inc., Seneca Falls, N. Y., for Bulletin 636.1. *Continued on Page 64*

S.S. White

FLEXIBLE SHAFTS SIMPLIFY DESIGN

. . . when space is at a premium

An S.S.White flexible shaft (arrow) takes power from an aircraft engine to drive a tachometer generator. This application clearly demonstrates the ready adaptability of S.S.White shafts to crowded space conditions.

Photo courtesy TWA, New York, N. Y.

• An S.S.White flexible shaft is a simple and effective way of transmitting power from one point to another through congested areas. The shaft can be run around, over or under any intervening obstructions as readily as electric wiring and, when properly applied, will perform as dependably and smoothly as a direct connection. For data about S.S.White power drive and remote control flexible shafts—

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It contains the latest information and data on flexible shafts and their application. Write for a copy today.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. L, 10 East 40th St.
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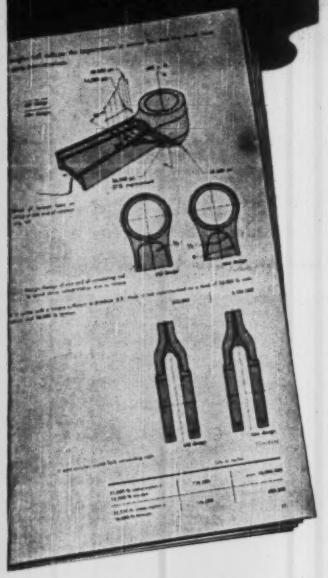
This book gives the answers..



How to avoid the localized stresses which start failure is a basic problem of design. This 72 page booklet analyzes many good and bad features of design. It also deals with problems of steel selection and treatment from the viewpoint of the design engineer —instead of the metallurgist.

Write for "3 Keys to Satisfaction"—it is free.

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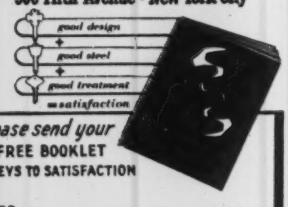

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ME-10 F21

Keep Informed

Worthington Hot-Z System

Bulletin W-212B7 on the Hot-Z System for treating boiler feed water is announced by Worthington Pump & Machinery Corp., Harrison, N. J.

The 6-page bulletin discusses development, filtration, backwash water, direct contact vent condenser, complimentary recirculation, backwashing, proportionate sludge removal and application of the Hot-Z. Included in the bulletin is a two-page questionnaire to determine the applicability of the Hot-Z System to particular conditions.

Ingersoll-Rand "T" Series Compressors

Ingersoll-Rand offers a new Bulletin describing their "T" Series Stationary Air Compressors. The "T" Series consists of two lines, one designed for normal industrial pressures of 100–125 pounds; the other rated at 200 pounds for continuous service, and up to 250 pounds on intermittent pump-up service. Both lines are available as tank-mounted, baseplate-mounted or bare units, with electric-motor or gasoline-engine drive. The units are air cooled by means of fan blades integrally cast on the flywheel.

Standard equipment includes a centrifugal unloader, intake filter and muffler, and automatic start-and-stop control on tank-mounted and baseplate-mounted units. Constant-speed and dual-control are optional equipment.

The bulletin shows various sizes and models and gives cross-sectional views, engineering data, sizes and dimensions.

For additional information write Ingersoll-Rand, 11 Broadway, New York 4, N. Y. or any of its branch offices, and request Form 1048.

High Pressure Pumps

New Aldrich Data Sheet 64-B describes the recently designed Aldrich 5" Stroke Multiplex Direct Flow Pumps. This 6-page bulletin covers design advantages, construction, specifications and drive requirements. Also included are: a pump selection chart; dimension drawings; plunger, pressure and capacity data on both the 5 and 7 plunger units. The capacity range of these two pumps, in bbl. per day at 100 rpm, is from 292 up to 5060 bbl. Maximum pressures range from 614 psi with $3\frac{1}{2}$" diameter plungers to 7500 psi with 1" diameter plungers. Copies of Data Sheet 64-B are available from The Aldrich Pump Co., 29 Pine Street, Allentown, Pa.

Automatic Vari-Pitch Drive

The automatic Vari-Pitch drive, a simple, low-cost method of instant speed control covering most speed changing needs from $1\frac{1}{2}$ to 40 horsepower, is described in a new 12-page bulletin released by Allis-Chalmers Manufacturing Co.

To increase the speed, when employing the drive, it is only necessary to move the motor toward the driven sheave; moving the motor away decreases the speed. Belt tension is automatically maintained and a speed variation of approximately 2 to 1 is possible.

According to the bulletin, the automatic Vari-Pitch sheave has been used successfully on all types of textile machinery; to vary the speed and rate of delivery of pumps, blowers and compressors; to provide variable speeds for variable frequency generators and many other types of testing machines; to synchronize speeds on packaging machinery and conveyors; to provide variable speed on machine tool spindles; to drive

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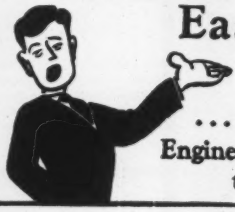

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mixers and agitators, and to vary the speed of many other types of equipment in many industries.

The bulletin carries instructions and tables to enable individuals to figure the components needed to assemble a drive for almost any speed range and horsepower within the range of this drive.

Copies of the bulletin, "Vari-Pitch Automatic Sheaves," 20B7223A, are available upon request from Allis-Chalmers Manufacturing Co., 949 S. 70th St., Milwaukee, Wis.

Ellison Diafram Type Straight Line Draft Gages

Bulletin 124 just off the press describes Diafram type straight line gages made by Ellison Draft Gage Co., 214 W. Kinzie St., Chicago 10, Ill. This type straight line gage differs from the Ellison bell type in that it is actuated by a diafram. A special silk fabric impregnated and coated with an air-tight synthetic material is used for the free floating diafram. This material resists cracking from repeated flexing. Other features described are the translucent ceramic scale, the non-parallax pointer for easy reading and bronze pivot bearings in the recording mechanism. Copies available upon request.

Air Relief Traps

Ball float traps for venting air from any liquid under pressure are described in a two-page bulletin recently issued by Armstrong Machine Works, 894 Maple St., Three Rivers, Mich. Typical applications for the traps are described as venting air from: hot water heating systems; water service lines; water storage tanks; centrifugal pumps, gasoline lines; dry cleaning solvent filters. Included are hookup diagrams, cross-sectional drawings of the traps and physical data and list prices of cast semi-steel and forged steel traps, both direct lever action and spring loaded snap-action types. Copies available upon request to the manufacturer. Ask for Bulletin No. 206.

Revised Bulletin on Liquid Level Indicators

20-page Bulletin WG-1823 describes liquid level indicators and auxiliary attachments for remote indication of liquid level in boilers, feed water heaters, storage tanks, etc. Auxiliaries include automatic control unit for operation of distantly located Hi-lo Alarm signal lights, signal horns or electric switches. Bulletin contains complete details—construction and operation, installation suggestions, dimensions, application diagrams, pictures of typical installations, how to specify, how to order, list of users, etc. Available on request. Write to Yarnall-Waring Co., 108 Mermaid Ave., Philadelphia 18, Pa.

Hi-Up Truck Mixer and Agitator

A new bulletin R-1700-B3 describing current models of Hi-Up Worthington-Ransome truck mixers and agitators is announced by Worthington Pump & Machinery Corp.

For central mixing plants, the following mixers are described: an 84-S mixer which gives a capacity load for a 3-yard Hi-Up Agitator; two 56-S (or one 126-S) giving correct load for a 4¼ yd. Hi-Up Agitator; and two 84-S Big Mixers having the capacity to service a 6½ yd. or a 7½ yd. Hi-Up Agitator.

Specifications, line drawings and pictures of the following sized truck mixers are also included in the bulletin: 3 cu. yd. mixer to service a 4¼ yd. agitator; a 4½ yd. mixer to service a 6½ yd. agitator; and a 5½ cu. yd. mixer to service a 7½ cu. yd. agitator.

In the 20-page bulletin are pictures and explanations of such features as the main frame, transmission, clutches, trunnion bearings, chain drive, water system, water tank and the flush tank, drum head, drum rollers, drip ring, hopper, seal and clutches. Manufacturing techniques are also discussed.

Revised Data Book on Reproduction Methods Published by Kodak

A new 72-page Data Book on the use of Kodagraph Reproduction Materials for office photocopying and engineering reproduction has been published by the Eastman Kodak Co.

The new edition replaces an earlier issue published in 1940 as a reference for reproduction departments.

Diagrams in the new edition graphically illustrate methods of solving special reproduction problems and both techniques and equipment are explained. Particular attention is given to restoration and reproduction of worn, damaged, or strained engineering drawings and to methods of eliminating handwork in cases where drawings must be changed.

Techniques of copying familiar business documents are fully explored and the book outlines suggested methods of organizing an

Continued on Page 66

Imperial

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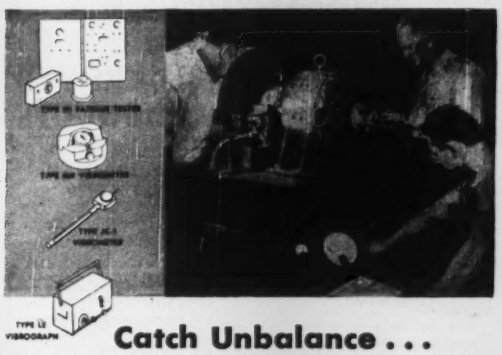

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Static and dynamic unbalance in rotating parts can cost you time and money. The Westinghouse Type HQ Portable Balancer is exactly the equipment to balance rotors at operating speeds in their own frame and bearings. Compact and with a wide operating range, this balancer is the leader in its field... just as are other types of Westinghouse vibration equipment.

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PORTABLE BALANCER

effective photocopy unit. A trouble-shooting guide lists causes of unsatisfactory prints and the remedies for them.

Priced at 50 cents, the book is available through Kodak Industrial Dealers or from the Industrial Photographic Division, Eastman Kodak Co., Rochester 4, N. Y.

Cut Felt Parts

Glenville, Conn.—A two-color four-fold mailing piece including samples of special precision-cut felt parts and giving considerable information about precision cutting and shaping of felt has been prepared by the American Felt Co. for its distributors and customers.

Technical literature containing more detailed information about American Felt products and their application is listed in the mailing piece which will be sent free to anyone on request.

15-Feature Varidrive Bulletin

A new, colorful Bulletin exhibiting 15 features of the recently developed low-priced line of fractional horsepower U. S. Varidrive motors is off the press. The Bulletin features the VA series of variable speed motors and illustrates seven modifications of the design, including three-phase and single phase, combination geared drives and types with flanged bracket for direct connection to the driven machine. Features of the VA Varidrive include: a new finger touch control handle, smaller dimensions, 10:1 speed range from 4 to 10,000 rpm, optional positioning of the control dial, knife-edge pointer for accurate selection of speeds, quick removable cover, universal mountings and positive lubrication. Ask for VA Varidrive Bulletin No. 1601. U. S. Electrical Motors Inc., 200 East Slauson Ave., Los Angeles 54, Calif.

Link-Belt Worm Gear Drives

Link-Belt Worm Gear Drives of three basic types, each available in 10 different sizes, for fractional or large horsepower, and in speed ratios of $3^1/_4$ to 1 up to 8000 to 1, are illustrated, described, tabulated in a new 80-page Book No. 2324 released by Link-Belt Co.

Features enumerated for these enclosed right-angle drives are—Compact design; anti-friction bearings; automatic splash lubrication; high ratios in small space; operation at high input speeds; quiet performance; and their availability for vertical or horizontal driving.

Pages 10 thru 15 contain typical drive problems with their solutions and show the ease with which the proper drive may be selected for a specific duty.

A copy of new Link-Belt Book No. 2324 will be forwarded to any interested reader upon request.

Helpful Table Available in Edward Valves' Magazine

East Chicago, Ind.—Included in the most recent issue of Valve Values, house organ of Edward Valves, Inc., East Chicago, Indiana, is a helpful pressure-temperature rating table conforming to ASA B16e6-1949.

This table on the inside back cover of the publication is compactly arranged for filing and for use under the glass tops of desks and is valuable for engineers concerned with pressure-temperature piping work. The ratings are used as standard by the ASME Boiler Code Committee, the ASME Code for Pressure Piping, most API divisions and others.

In the same issue of Valve Values, an article describes in detail new testing techniques used in the design of Edward valves for lower pressure drop and minimized turbulence. The new Edward laboratories are also described and pictured.

"Asbestos-Bonded" Pipe for Severe Service Conditions

A 6-page folder entitled "Here's the Drainage Structure with a 'One-Two' Punch" issued by Armco Drainage & Metal Products, Inc., Middletown, Ohio, describes the structural strength and material durability of Armco "Asbestos-Bonded" Pipe to withstand severe conditions. It also describes how "Asbestos-Bonded" Pipe is made. Photographs illustrate test installations and installations of industrial sewers and culverts in marshy and salt water conditions.

Hand-Held Rock Drills

A new bulletin, H-1200-B38, on Hand-Held Rock Drills has been published by Worthington Pump and Machinery Corporation.

The bulletin contains pictures and specifications for the WS-45 drill with cylinder bore of $2^1/_8$", 52-pound weight and 19" length. The WS-55, with cylinder bore of $2^3/_8$", weighs $62^3/_4$ pounds and is $20^1/_2$" in length. The third drill described is the WS-30 drill with cylinder bore of 3", is 83 pounds in weights and $23^3/_4$" in length.

Design features are described and screw feed mountings specified in the bulletin.

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You can be sure if your products pass a vibration fatigue test—substantiates design and construction materials—frequently exposes excessive material. Many things can be learned from tests. A "must" for electronic, aircraft and automotive parts and assemblies. Hundreds in use. Models to handle parts from 10 lbs. to 100 lbs.—choice of vertical or horizontal table movement. Frequencies of 600 to 3,600 v.p.m. Special machines to order. Catalog F contains treatise.

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We made several of these big Casing Guide Vanes, as shown by the photo of the rough casting, left . . . the alloy was 88% copper, 10% tin and 2% zinc.

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We've also made numerous similar type castings for Turbine Runners, Pump Impellers . . . and hundreds of large, accurate Ship's Propellers.

So, if you require nonferrous castings (large or small) to meet any of the following conditions, you are safe in bringing your problems to us: Corrosion Resistance; Strength in Tension and Compression; Hardness and Toughness. Pressure Tightness; Erosion Resistance; Frictional Wear Resistance or Fatigue Resistance. Would you like a copy of our famous 40-page flexible-bound Reference Book entitled, "*Bronze Casting Alloys*"? If so, write us on your business letterhead.

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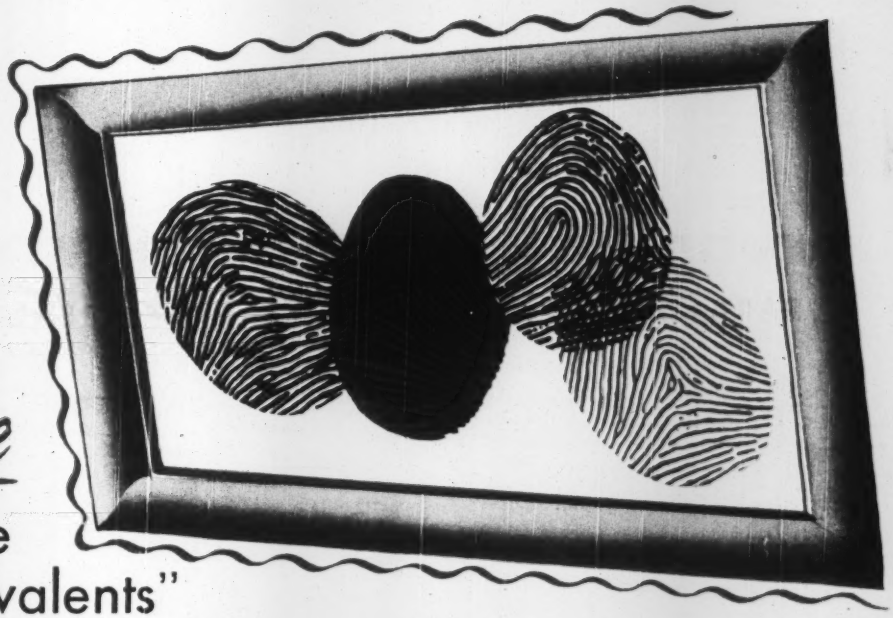
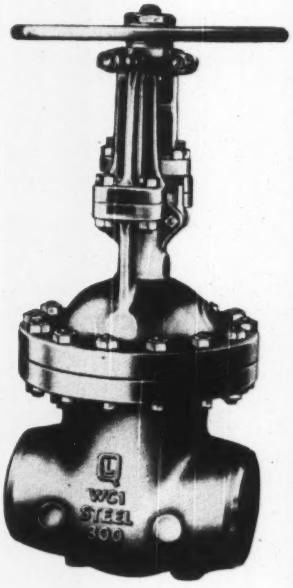


are there "equivalents" to **LUNKENHEIMER** STEEL VALVES?



Well, there are "alternates." But the engineer's familiar specification, "Lunkenheimer Figure 1938 or equivalent," invites a comparison with your thumbprint — and your neighbor's. How "equal" can valves really be? A few characteristics can *almost* be matched. But there is no equal for most Lunkenheimer features. Consider the metal quality of Lunkenheimer steel castings. Their soundness is unparalleled in the valve field. Lunkenheimer metallurgical research has uncovered whole new areas of study, developed exclusive alloys, pioneered in methods of quality control. The amazing records of safety and long service life achieved by Lunkenheimer steel valves are evidence that there *is* no real equivalent for Lunkenheimer metal quality. In workmanship, too, the famous Lunkenheimer tradition of care and precision has never been equalled. New machines (most of Lunkenheimer's machinery is less than three years old) are making possible *even higher* standards of workmanship. The *only* equivalent to a Lunkenheimer steel valve is another of the same design —a Lunkenheimer. For the address of your nearest representative, and for more steel valve data, write to The Lunkenheimer Co., P. O. Box 360E, Cincinnati 14, Ohio.

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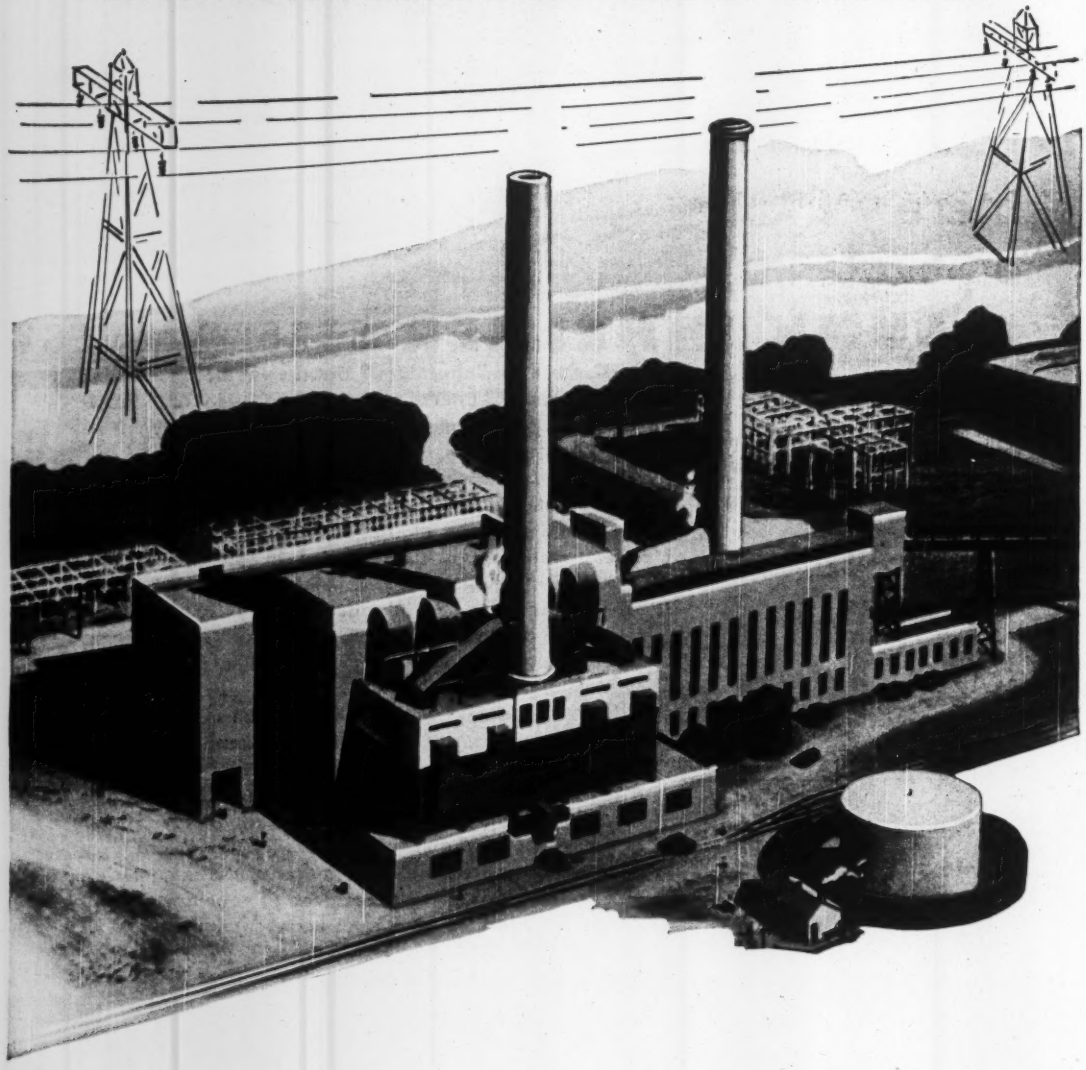
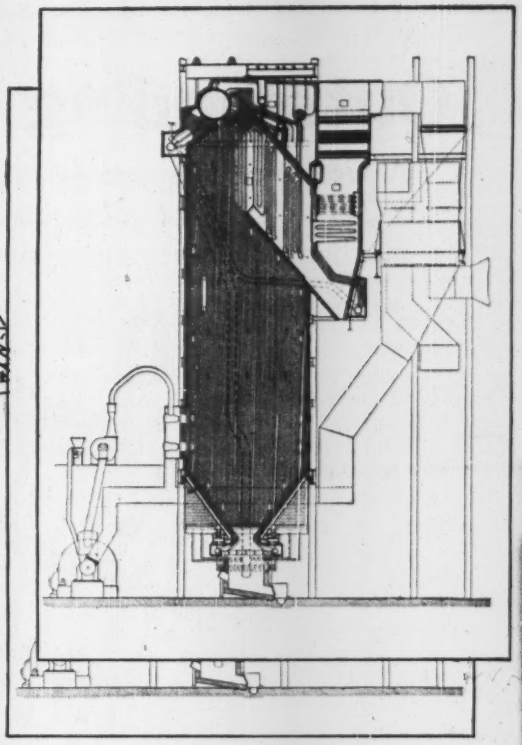
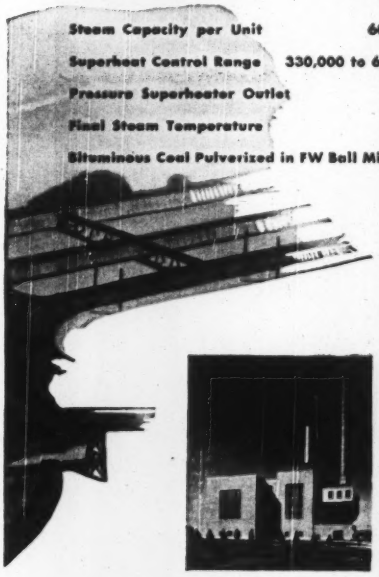


Two FOSTER WHEELER steam generators supply steam for the new turbines at BARBADOES STATION of PHILADELPHIA ELECTRIC COMPANY.



Steam Capacity per Unit	600,000 lb per hr
Superheat Control Range	330,000 to 600,000 lb per hr
Pressure Superheater Outlet	825 psi
Final Steam Temperature	900 F
Bituminous Coal Pulverized in FW Ball Mills (two per unit)	



The growth in the supply of electric power keeps pace with the rising population and productivity of Philadelphia's highly industrialized Schuylkill Valley since two 66,000-kilowatt turbo-generator units were installed a year ago in the $24,000,000 expansion of the Philadelphia Electric's Barbadoes Station. This station, which has a total capacity of 180,000 kilowatts — enough for the needs of 500,000 homes — is part of the Company's electric system covering an area of 2,255 square miles and serving more than 900,000 customers.

A total of 1,200,000 lb of steam per hr is supplied to the new turbo-generators by two Foster Wheeler Steam Generators which have a performance record proving the advantages of such Foster Wheeler design features as slag-free furnace arrangement, low draft loss, and efficient heat recovery arrangement. Each unit is fired by two Foster Wheeler Ball Mill Pulverizers with facilities to permit full load operation with coal or gas.

The most advanced techniques permit the handling of 12,000 tons of coal, 30,000,000 pounds of steam and 250,000,000 gallons of water each day at Barbadoes. Only 11 men per shift are required to operate the two new units and steam generators.

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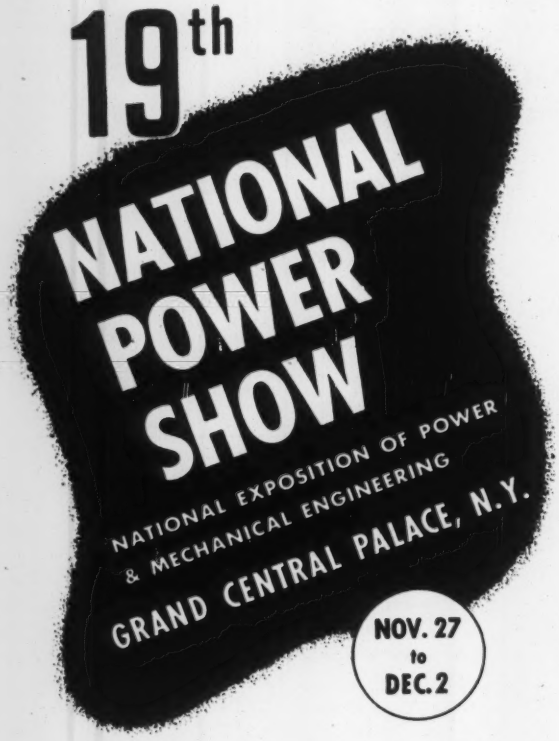

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A low-cost, photographic intermediate paper that produced positive copies directly was "big news" for Crompton & Knowles, world's largest manufacturer of specialty looms. To begin with, it meant that they could reorganize their filing system much faster and much more economically than had been estimated. *Here was the problem:* they had some 200,000 detail drawings—4 to 8 on each sheet of paper. Many of these were not in sequence, which slowed reference; and, when blueprints of only one part were needed, it meant a waste of paper . . . besides taking the attached drawings out of the files. *Solution:* the design sheets were reproduced on Kodagraph Autopositive Paper; then the prints were cut and filed correctly in the "master" file.

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Crompton & Knowles has adopted the rule: "*A Kodagraph Autopositive intermediate of every drawing.*" And this is paying off today in lower re-drafting costs. *Before*, the original detail drawings (described above) and scale drawings were used as the blueprint "masters" . . . were exposed to machine wear-and-tear, constant handling. When they no longer produced legible blueprints, they had to be redrawn. *Now* the valuable originals are kept safe in the files—available for reference and revisions only. The "Autopositives" do the "heavy work" . . . whenever needed.

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Using Kodagraph Autopositive intermediates, Crompton & Knowles turns out sharper, cleaner blueprints—at uniform, practical machine speeds.

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Please mail a copy of "Modern Drawing and Document Reproduction"—your new free booklet on Kodagraph Autopositive Paper.

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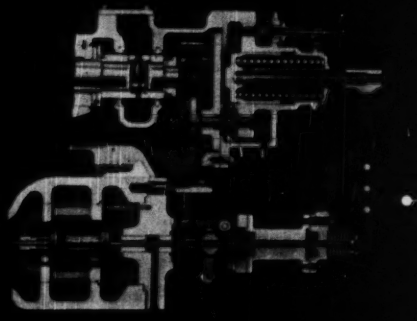
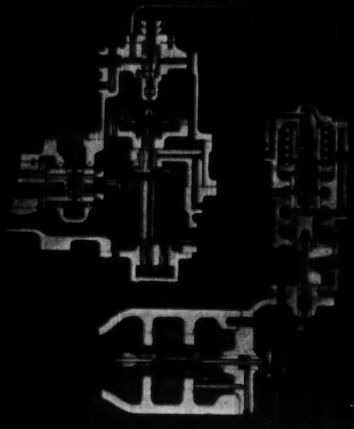
FOR CLOSE-LIMIT SPEED CONTROL (6-8%)

The Standard Shaft-Type Governor is mounted on the turbine shaft and protected by a sturdy cast-iron housing, able to take a man's weight. This centrifugal-weight governor automatically positions the steam admission valve to control turbine speed within close limits—between 6 and 8 percent speed regulation. When equipped with a hand speed changer, this governor permits speed adjustment up to 20 percent of the rated speed.



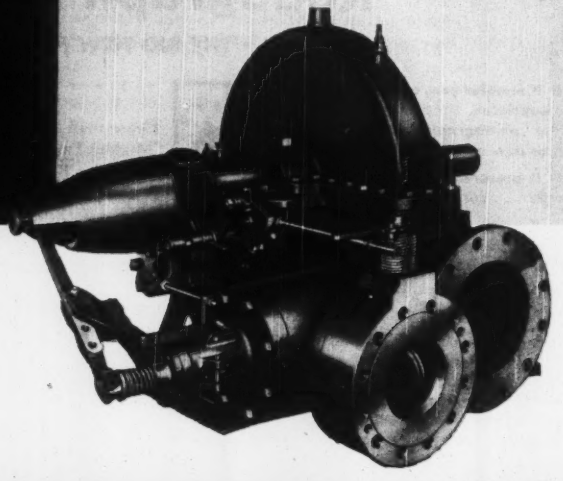
FOR VARIABLE-SPEED APPLICATIONS (6%)

The Hydraulic-Orifice Governor provides a 3-to-1 maximum speed adjustment and a speed regulation of 6 percent. The hydraulic-orifice type is particularly suited for variable-speed applications, such as drives for fans, blowers and compressors. Oil pressure for governing and lubrication is supplied by a shaft-driven, gear-type pump.



FOR WIDE-RANGE PRECISION CONTROL (4%)

The Vertical Oil-Relay Governor provides the quality of speed regulation required for generator drives or other applications requiring close regulation. It also provides the power required to handle large steam flows. It affords speed regulation of 4 percent and may be provided with a maximum speed adjustment of 3-to-1 with integral pump . . . and higher with a separate motor-driven pump. It is a frictionless centrifugal-weight, speed-responsive element combined with an oil pump and servomotor. With speed-compensating parts this governor is ideal for paper-machine drives.



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PRECISION CONTROL for all Speed Problems

Here's the kind of governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

The expense of special engineering is eliminated. Advanced design now gives you an unusual degree of flexibility . . . with precise speed control for all steam conditions. Results? First costs are lower—shipments are quicker—spare-parts inventory is reduced.

Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. What's more, Type E governors can meet a limitless number of special requirements with optional accessories. Westinghouse's wide experience in all industry enables you to realize the benefits of this progressive standardization.

Simplicity and flexibility of governors is but one of the outstanding advantages of the Type E turbine. Consider these important Westinghouse maintenance-saving features . . . Dual Protection . . . Weather Protection . . . Centerline Support . . . a Rugged Governor Housing. They're your assurance of extra reliability, safety, and economy. Ratings are available from 5 to 1,500 hp.

There's a Westinghouse Steam Specialist near you who will be glad to help with your speed-control problems. A complete study of your power application will be made without obligation. These recommendations may point the way to substantial savings in power costs, in greatly increased production. Call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

Ask for Type E Turbine Book, B-3896.

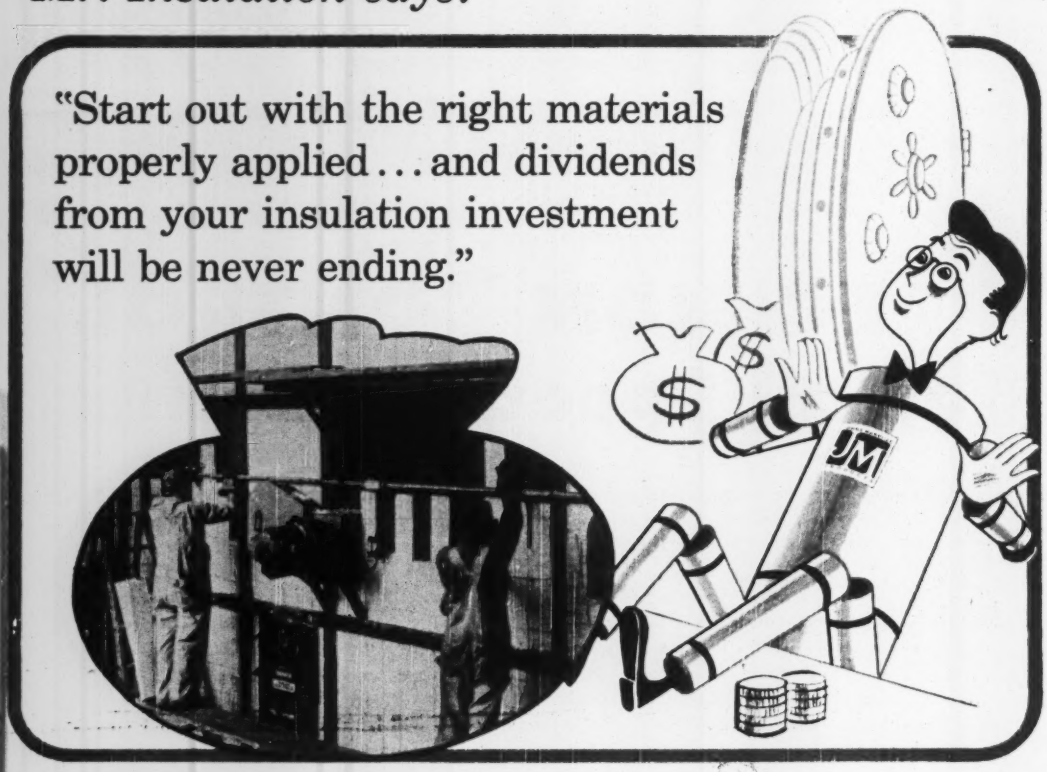
J-50515

Westinghouse TYPE E Turbines

WESTINGHOUSE

Mr. Insulation says:

"Start out with the right materials properly applied . . . and dividends from your insulation investment will be never ending."



Here are two important reasons why it will pay you to let Johns-Manville serve as your insulation headquarters:

YOU GET THE RIGHT MATERIALS — Regardless of the service conditions on your job, Johns-Manville has an insulation that fits the need. That's because Johns-Manville manufactures a wide variety of insulations of asbestos and other selected raw materials—for service from 400F below zero to 3000F above. Johns-Manville offers this complete line because industry requires many types of insulations and because no one material can properly serve as a jack-of-all trades for use on all jobs.

YOU GET THE RIGHT APPLICATION— Insulations serve at top efficiency only when properly applied. J-M Insulation Contract Firms have men with generations of insulation experience and training in Johns-Manville application methods. The way they engineer your job is your assurance that your insulation investment will pay a high return through the years.

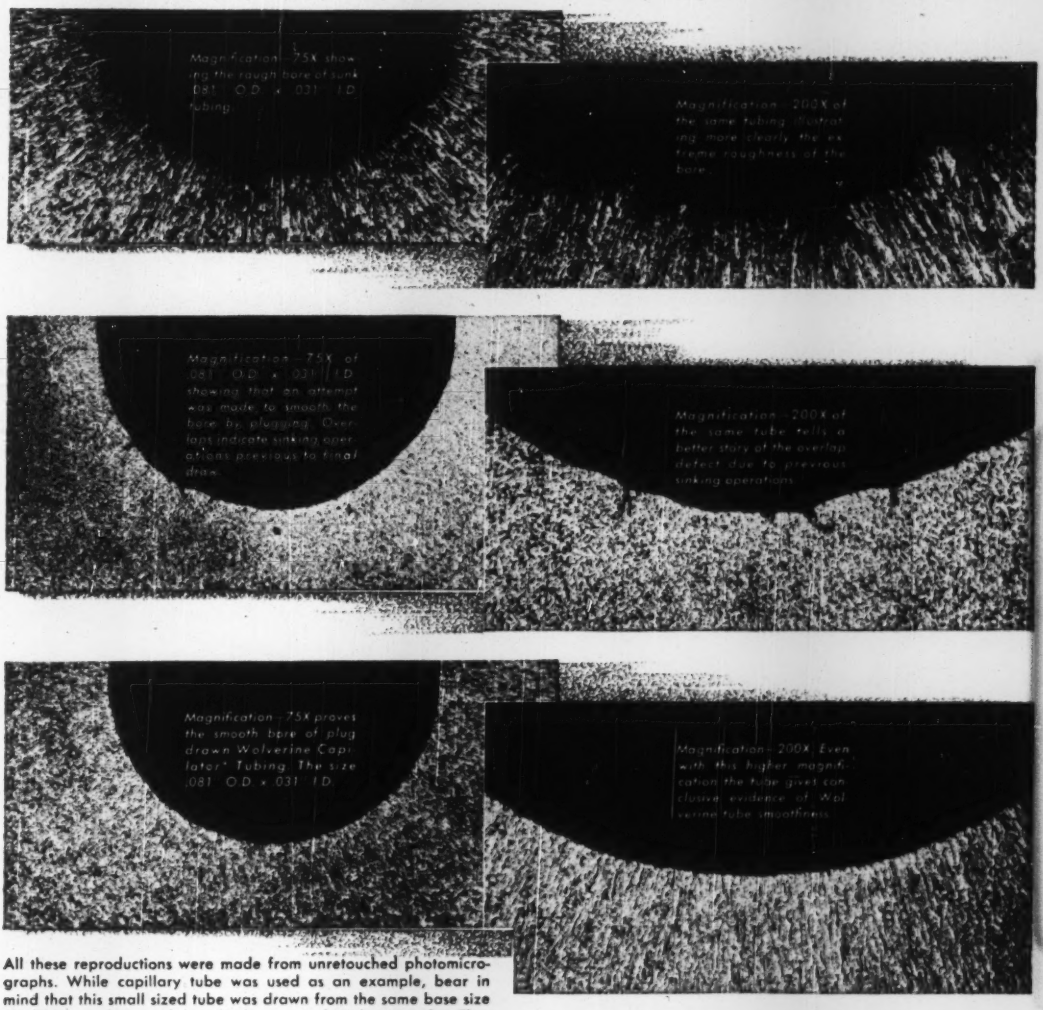
Why not call on insulation headquarters for engineering advice about your insulation work. J-M Insulation Engineers are available to help select the *right* insulation for your particular service conditions. Write Johns-Manville, Box 290, New York 16, N.Y.

Johns-Manville *first in* **INSULATIONS**

WHICH TUBE WOULD YOU CHOOSE?

These photomicrographs show the transverse sections of three brands of capillary tubing.

They tell their own stories and prove the truth of our statement that "There IS a difference in tubing."


Magnification—75X showing the rough bore of sunk .081 O.D. x .031 I.D. tubing.
Magnification—200X of the same tubing, illustrating more clearly the extreme roughness of the bore.
Magnification—75X of .081 O.D. x .031 I.D. showing that an attempt was made to smooth the bore by plugging. Overlaps indicate sinking operations previous to final draw.
Magnification—200X of the same tube, tells a better story of the overlap defect due to previous sinking operations.
Magnification—75X proves the smooth bore of plug drawn Wolverine Capillator* Tubing. The size .081 O.D. x .031 I.D.
Magnification—200X. Even with this higher magnification the tube gives conclusive evidence of Wolverine tube smoothness.

All these reproductions were made from unretouched photomicrographs. While capillary tube was used as an example, bear in mind that this small sized tube was drawn from the same base size (3" O.D.) used to produce all other sizes of Wolverine tube. Thus this evidence of quality applies to ALL Wolverine tube, regardless of size.

Which tube would you choose? Of course, you'd choose the tube which would allow the smoothest flow of liquid or gas—and, in the long run, give you the most economical service. You'd choose dependable Wolverine tube.

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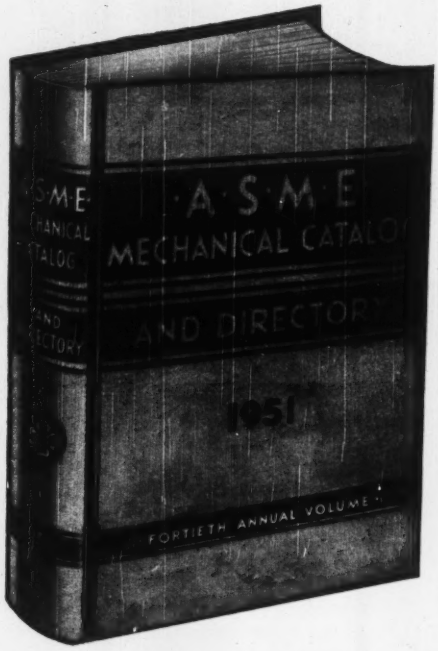

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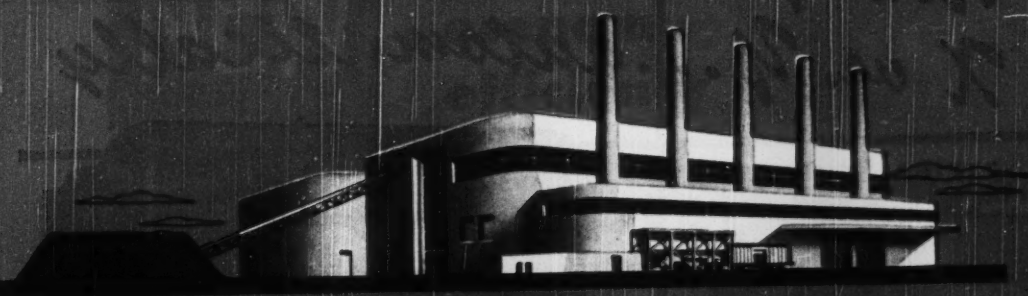

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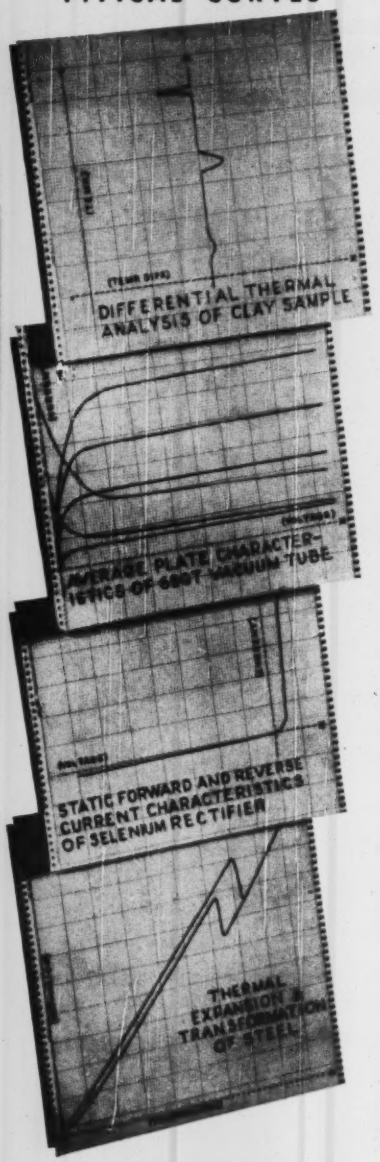
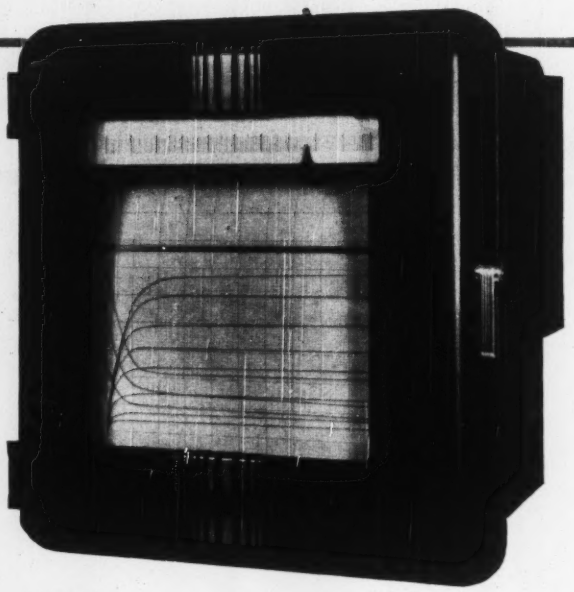

DIFFERENTIAL THERMAL ANALYSIS OF CLAY SAMPLE
AVERAGE PLATE CHARACTERISTICS OF 6SQ7-VACUUM TUBE
STATIC FORWARD AND REVERSE CURRENT CHARACTERISTICS OF SELENIUM RECTIFIER
THERMAL EXPANSION & TRANSFORMATION OF STEEL



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New Speedomax 2-Function Recorder

Boon to engineering and research laboratories, this new Speedomax Recorder automatically plots a continuous, accurate curve showing the relationship between any two variables brought to the instrument in the form of d-c signals. Gone are those hours of tedious compilation and point-by-point plotting of data.

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For details, send for Folder EM9-420(1). Write us at 4963 Stenton Ave., Philadelphia 44, Pa.

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Duti-Rated helical gears made to precision accuracies and having file hard tooth surfaces (60 Rockwell C) offer the maximum in long life and quiet operation. Gear tooth cores are processed to maximum strength and ductility for resistance to intermittent peak overloading conditions.

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For easier, better welding...

GRINNELL WELDING FITTINGS

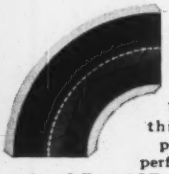
A qualified welder can make welds quickly and easily with Grinnell Welding Fittings. These fittings are made by a hydraulic forging process that assures uniform wall thickness at all points and true circularity throughout. Of seamless, one-piece construction, they can be cut at any angle to match up with standard weight, and extra strong and heavier wall pipe in I.D. or O.D. sizes. Pressure-temperature ratings are equal to or greater than those of seamless steel pipe. Grinnell Welding Fittings are process stress-relieved.

Permanent Identification

Each Welding Fitting bears a metal plate giving size, wall thickness, material and name for easy, positive identification.

Full Length Outlets

Full length outlets permit fast lining up and ample room for rod manipulation; keep high welding heat away from vital crotch zones.



Uniform Wall Thickness

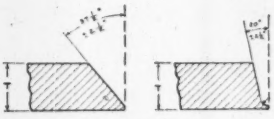
Uniform wall thickness at all points permits perfect lineup with pipe, O.D. and I.D. No thinning of long outer wall . . . no thickening of short inner wall. Complies with code requirements.

True Circular Section

True circular section at all points makes fitting easy to align and weld . . . no distortion or flattening to affect flow adversely.

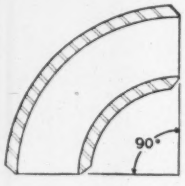
Plain Circumferential Butt Welds

Grinnell Welding Fittings confine all welds to plain circumferential butt welds — with their inherent strength and simplicity.



Accurate Bevels

Accurate bevels aid aligning and welding. Standard straight bevel for thickness (T) 3/16 to 3/4 inch inclusive. Standard U-bevel for thickness (T) greater than 3/4 inch.



True Included Angles

True included angles permit fabrication and erection of complicated piping systems to exact measurements.

Send for copy of this new catalog showing the complete line of Grinnell Welding Fittings and Forged Steel Flanges.

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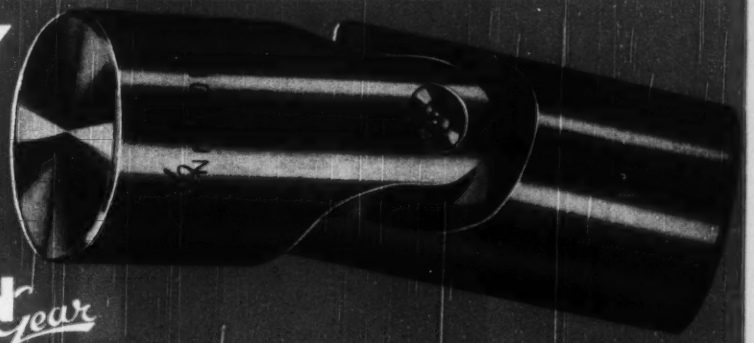
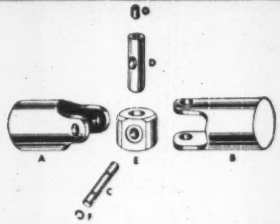


BOSTON Gear

the best Universal Joint is also the Easiest to Get

— best in design — best in quality of materials and workmanship (all parts interchangeable) — best in performance

— stocked in all standard diameters, solid and bored by eighty Boston Gear Distributors, one right handy to you.



WHY BOSTON'S BEST

Boston Gear Universal Joints are engineered for high load carrying capacity and high static torque ratings. They are compact, smooth running, long-lived. They equal or exceed Government Specifications in every respect.

YOKES (A & B) are constructed of highest quality, heat treated alloy steel with bearing surfaces precision ground and O. D. ground to +.000, −.001 for concentricity.

BEARING PINS (C & D) are hardened and precision ground.

CENTER BEARING BLOCK (E) is hardened and precision ground. Holes intersect accurately to provide true bearing surfaces.

SELF-LOCKING ASSEMBLY RING (F) of specially selected spring steel, snap locks into recesses in small bearing pins and center bearing block.

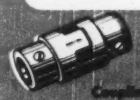
SELF-CLOSING, BALL VALVE OILER (G) provides an oil reservoir for safe, sure lubrication.

THESE PRECISION PARTS ARE INTERCHANGEABLE

BOSTON Gear stocks are HERE★

BOSTON UNIVERSAL JOINTS, like all of the 101 Boston Gear Power Transmission Products and Parts are readily available from stock at your local Authorized Boston Gear Distributor. Name on request.

FOR COMPLETE INFORMATION on Boston Universal Joint stock sizes, HP ratings and breaking loads consult the new Boston Gear Catalog No. 55. Copy mailed on request.



BOSTON GEAR WORKS

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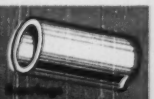
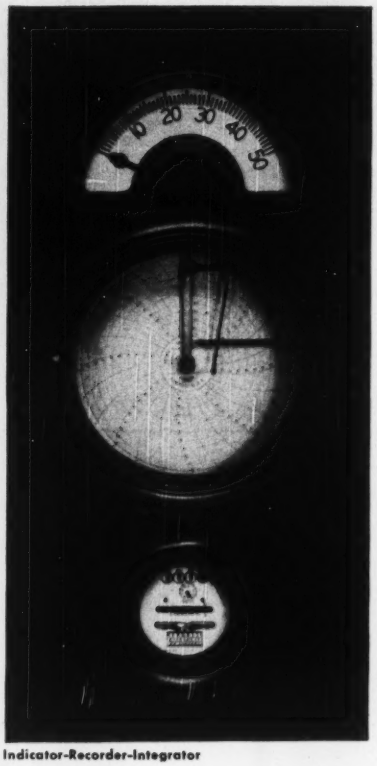


Integrator



Indicator-Recorder-Integrator

Varying flows are accurately totalized because the integrator is continuous

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

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Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

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Dowell Service cleaned seven heat exchangers in 19 hours!

This refinery had 7 heat exchangers that were badly fouled. Minimum downtime for cleaning was a prerequisite to maintain production. Dowell Service removed 80% of the deposits from the process sides in only 19 hours. As a result the operating pressure drop through the system was lowered from 80 p.s.i. to 5 p.s.i. with an equally satisfactory drop in operating temperatures.

Dowell Service is the answer to the maintenance engineer's demand for *fast, efficient, economical* cleaning. Maintenance time and costs can be cut by applying Dowell Service to condensers, process towers, boilers . . . to nearly any type of industrial equipment. Dowell engineers fill the equipment to be cleaned with liquid solvents. These solvents are designed to clean places inaccessible to other methods. Costly dismantling is eliminated and downtime is shortened.

What's *your* cleaning problem? Dowell Service Engineers will be glad to consult with you on *better, faster* methods of cleaning your equipment. No obligation, of course. Dowell Service is as near as your telephone.

Other recent Dowell jobs:

Oil, water, algae emulsion removed from refinery circulating water system in only 6 hours.

•

Water side of 15 tube and shell condensers cleaned for refinery. After Dowell Service, gasoline left condenser 20° cooler than when condensers were mechanically cleaned. Chief engineer estimates Dowell Service paid for itself in approximately 12½ days.

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Partially carbonized oil and grease caused trouble in five 150,000 lb./hr. boilers in a Southwestern refinery. Dowell Service removed the deposits from each boiler in a few hours.

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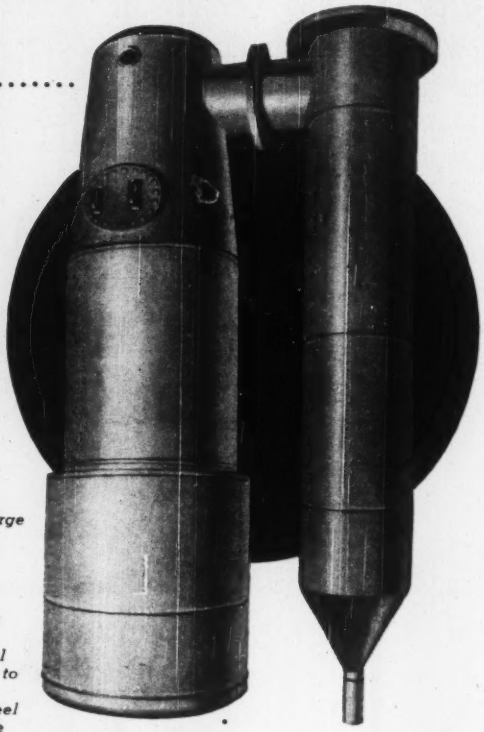
ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

Efficiently Designed Evaporator Cuts Tomato-Processing Cost



PROJECT: *To process tomato juice into paste without impairment of flavor, color or vitamin content. Important requirements: equipment must be adaptable for processing large or small batches of juice; prevent waste from boil-overs and scorching; be economical from standpoint of fuel and maintenance.*

DESIGN: *Evaporator with jacketed lower portion. Jacket is divided into two heights to handle without scorching small or large batches of juice under vacuum at 133° F boiling point. The main evaporator column is of Lukens Stainless-Clad Steel with smooth sodium hydride finish on inner stainless surface to protect product and make cleaning easy; steel backing to provide strength, rigidity and high heat transfer from mild steel steam jacket. Added length of column above jacket to provide extra evaporation area and prevent boil-overs into mild steel condenser column.*

END RESULT: *Tomato paste with rich red color and high vitamin content assured. Less fuel required; product quality improved; maintenance time and cost lowered; no waste from boil-overs. Equipment meets varying raw material supply requirements.*

We'll be at the National Metal Exposition in Chicago; Oct. 23-27; Booth 1628. Our Technical Staff will be on hand to greet you and help answer your problems.

In this, as in other food processing applications, the coordinated ingenuity of designer, engineer, fabricator and materials supplier resulted in the efficient answer to an equipment problem. This was the result of *Lukenomics*. For Lukenomics combines the experience of equipment designers and builders with Lukens' knowledge of materials and their application, gained over 140 years as the world's leading producer of specialty steel plates, heads and steel plate shapes.

It's sound judgment to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them, or write our Manager of Marketing Service, stating your problem. Lukens Steel Company, 402 Lukens Building, Coatesville, Pennsylvania.

C. E. MacPherson fabricated the vacuum steam cooking kettle illustrated above for Edgewater Canners using Type 347 Lukens Stainless-Clad Steel.

LUKENS

LUKENS STEEL COMPANY

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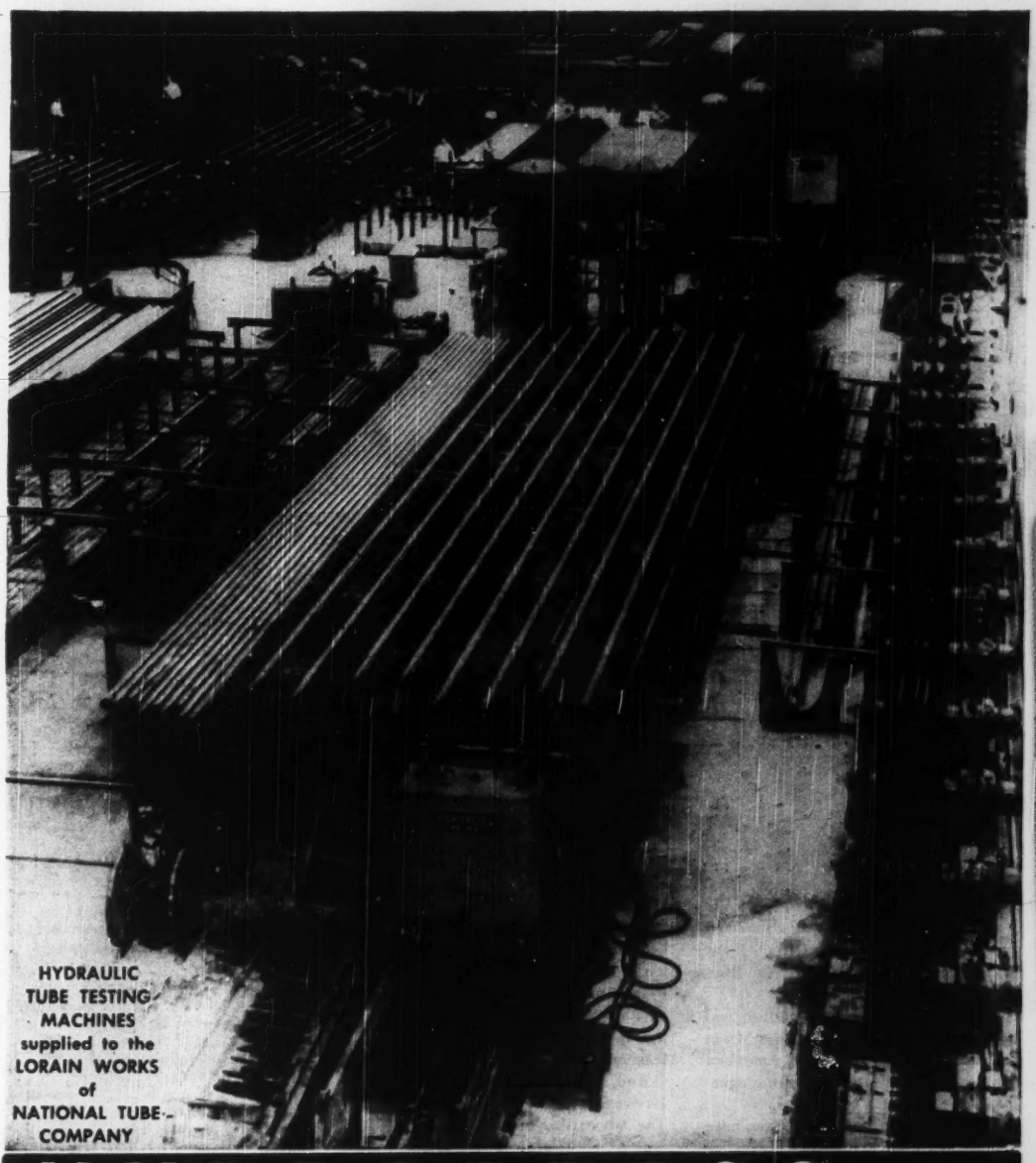

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"Marshalling the forces of advertising to help solve national problems and to make democracy work better . . ."

Do YOU KNOW that the forces of advertising are engaged today in one of the world's greatest jobs of mass education . . . *in the public interest?*

Do you know that these forces for good have been released through the vision and unselfish cooperation of American business – advertisers, advertising agencies, media owners and others?

Hundreds of advertising agencies have volunteered their planning and creative time and facilities. Artists, cartoonists, photo-engravers, printers, typographers and others have contributed their services.

Media owners have donated millions of dollars in space and time. National and local advertisers have sponsored and paid for many millions of public service advertising messages.

As a result, the American people are being alerted as never before to the dangers which threaten from within and from without . . . the dangers of ignorance about our American economic system, intolerance, tuberculosis, school and teacher shortages, etc.

And, at the hub of this great public service effort is *your* organization . . . The Advertising Council.

Advertisers and Media Owners . . . Your Help is Needed!

Right now The Advertising Council has 14 programs in operation. The success of these programs depends on the public spirited and generous cooperation of advertisers and media owners. *Your* help, in the form of space or time donations, will mean a lot to us. And remember . . . *What helps America helps you!*

Yours for the Asking

Write for a copy of Booklet No. 15. It will give you pertinent information about The Advertising Council . . . how it started . . . what it is . . . what it does . . .Or ask for material on specific campaigns. Address: – The Advertising Council, 25 West 45th Street, New York 19, N. Y.

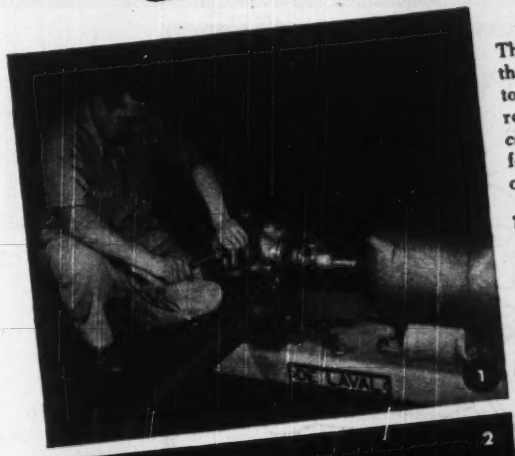
Published in the public interest by

MECHANICAL ENGINEERING

*A NON-PROFIT ORGANIZATION FORMED TO UTILIZE ADVERTISING IN THE PUBLIC GOOD

When a pump's in trouble . . .

IT'S SERVICE THAT COUNTS!



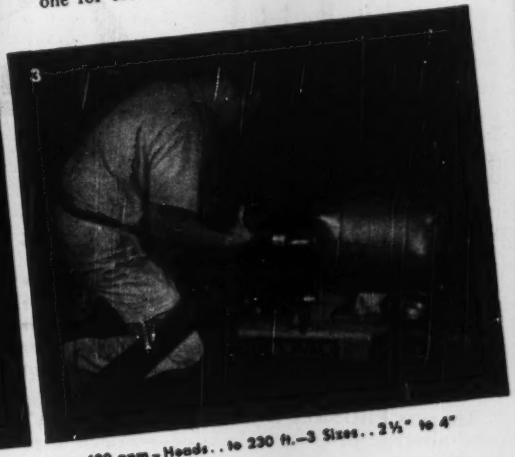
That's why we designed our new GS pump so that every working part . . . every part subject to wear . . . is contained in one easily replaced rotor assembly. Through our *Service and Exchange Plan*, new rotor assemblies are available for immediate shipment from conveniently located stocks throughout the country.

Then, when maintenance does become necessary here's all you have to do:

1 Remove the cover and the end plate studs.

2 Lift out the old rotor.

3 Drop a new one in place and return the old one for credit on serviceable parts.



Capacities . . to 400 gpm – Heads . . to 230 ft. – 3 Sizes . . 2½" to 4"

DE LAVAL STEAM TURBINE CO. *Trenton 2, N. J.*

BP-23

DE LAVAL STEAM TURBINE CO.
Trenton 2, New Jersey

Please send me a copy of your new GS Pump Bulletin.

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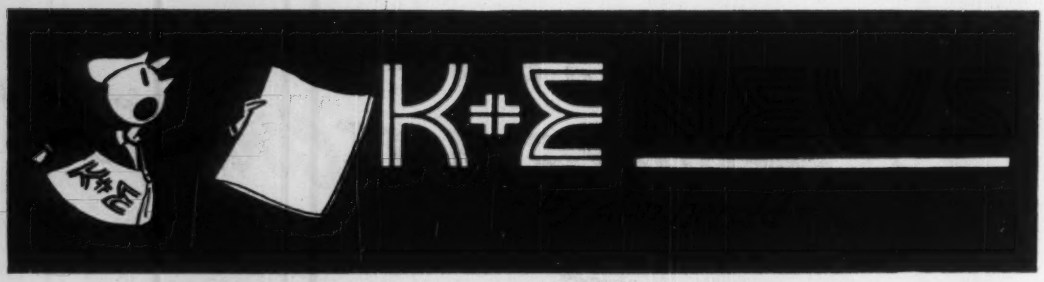
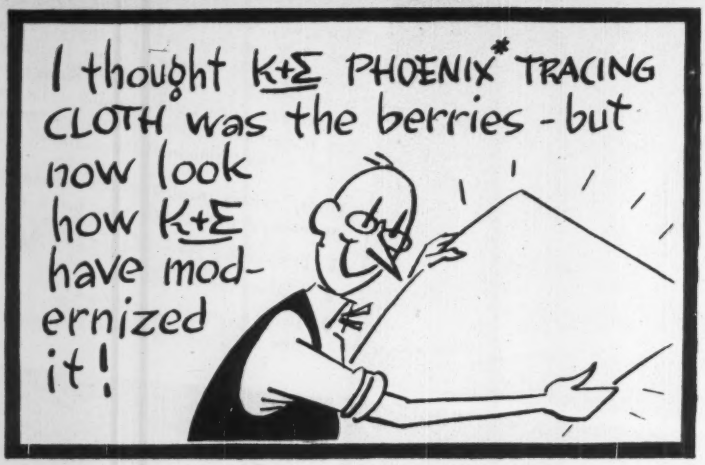




how good can a tracing cloth get!

PHOENIX* Tracing Cloth always did feel good to an engineer's pencil, but, now, new improved N166 PHOENIX feels better than ever—performs better—is better. It's whiter than ever—which gives it better contrast for pencil line drawings. (This helps reprint transparency.)

The new PHOENIX is toughened to take today's new vigorous printing techniques—repeated trips under higher powered lights or through hotter printing machines.

The new N166 thrives under an ultra-violet test, which equals thousands of prints on a machine, or years of exposure to daylight. No appreciable yellowing.

Improved PHOENIX resists heat of glass cylinders even as high as 250° to 275°. Will not stick.

K&E have also given this cloth a Bureau of Standards three day 212° heat test, which is the equivalent of years of aging. It retains its whiteness remarkably well.

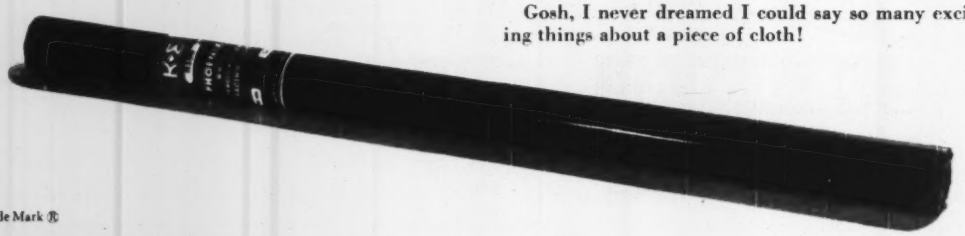
The new PHOENIX resists ammonia vapors and discoloration by contact with diazo prints in storage.

Its surface takes friction heat of motor erasers without softening or stain.

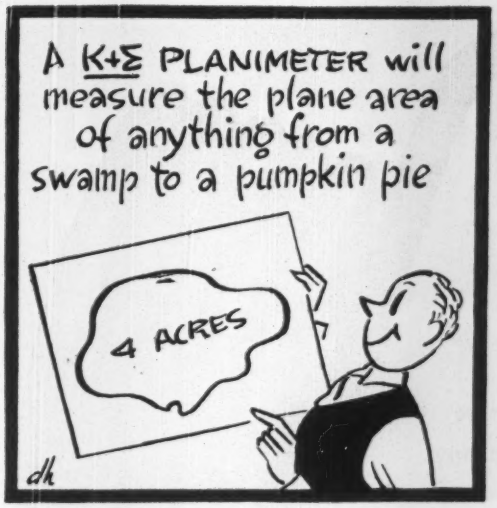
2-way water resistant

Both sides of the new PHOENIX are wonderfully water-resistant. This is important, since, if one side is more water-resistant than the other, the weaker side runs the show. By water, I mean water AND perspiration.

Gosh, I never dreamed I could say so many exciting things about a piece of cloth!



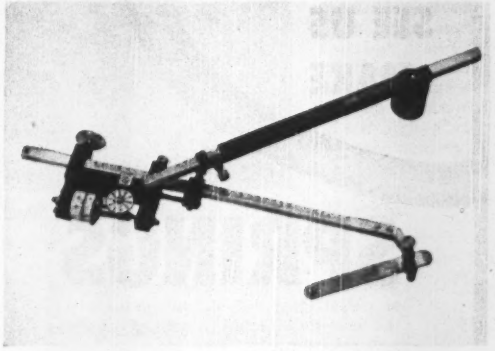
*Trade Mark ®



—and it's loaded with inbuilt K&E precision

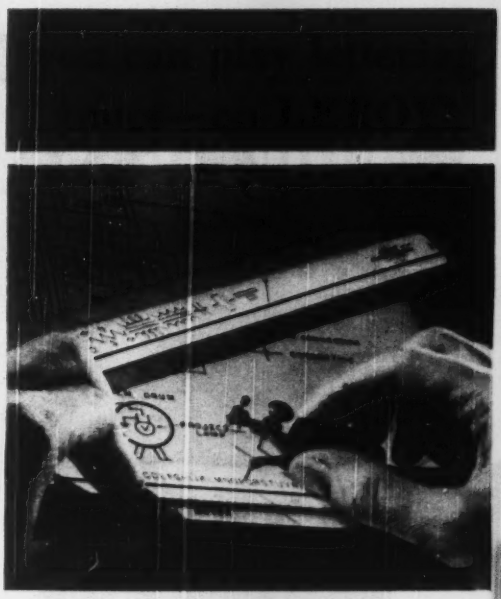
Don't ask me *how* it works. It's Greek to me. But you engineers probably understand that a planimeter will measure the area of an irregular plane if you push a little point accurately around its outline.

Engineers also tell me a planimeter has to be about the most accurate thing on wheels, or it will tell falsehoods. If it has rheumatism in any of its joints, water on the knee, or a crick in its funny bone, watch out.



Engineers tell me that K&E COMPENSATING POLAR PLANIMETERS are built beautifully for long-lasting cat's-whisker precision—that is, unless you go dropping them on the floor or using them to fight mosquitos.

A new K&E Manual comes with each instrument. It includes description of a unique method, which greatly increases the size of the area that can be measured.



LEROY is as versatile as a 1-man band.

You can have standard Gothic alphabets in a variety of sizes, plus many other type styles—Condensed, Extended, Reversed, Outline Gothic, Cheltenham, etc. Everything, including strawberry and vanilla.

Then there are Symbol Drawing Templates—Electrical, Welding, Map, Geological and Mathematical.

Also special templates made specially to order: trade marks and designs, frequently used words and phrases. Tell your K&E distributor or branch or the factory at Hoboken what you want. Send for a "LEROY Lettering and Symbols" booklet.

In case you don't know it, LEROY is a "controlled" lettering device used in thousands of drafting rooms. Swift and sweet. No smearing. No swearing.

You can form perfect letters the first time, and achieve speed and skill in a matter of minutes.

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

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For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

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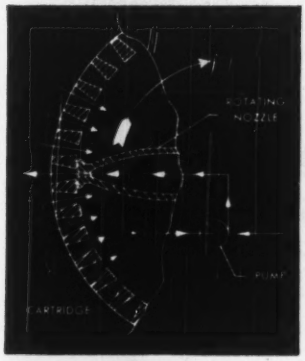
Save Water Automatically

and save money, too!

If water's scarce in your community, here's a painless way to cut down consumption.

If water isn't scarce yet, it's still expensive (particularly if you have to heat it or treat it), and here's an easy way to cut down its cost.

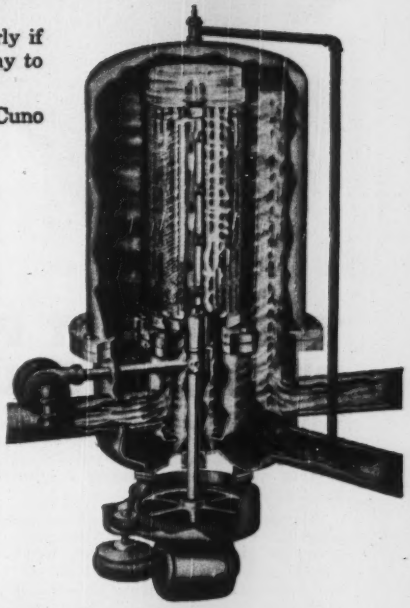
Make dirty water *fit for use* and *re-use* with a Cuno FLO-KLEAN Strainer.



Permanent, Resists Abrasion and Corrosion

Cuno Flo-Klean Filter makes raw water suitable for many plant services . . . keeps recirculated water clean . . . *pays for itself in as short a time as a year.* Permanent wire-wound cartridge positively removes all solids larger than spacing specified.* Pressure drop is exceptionally low because fluid moves in a straight line, encountering only momentary restriction.

**Available spacing from .0025 in. to .020 in.*



Continuously self-cleaning without fluid waste

There is no loss of backwash fluid. Used backwash is returned to the system. With no interruption of flow for cleaning the strainer, no duplex installation is needed. Operation, including sludge removal, may be completely automatic.

No Fluid Is Better Than Its Filtration

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Find Out How to Save Money

cleaning any fluids containing abrasives

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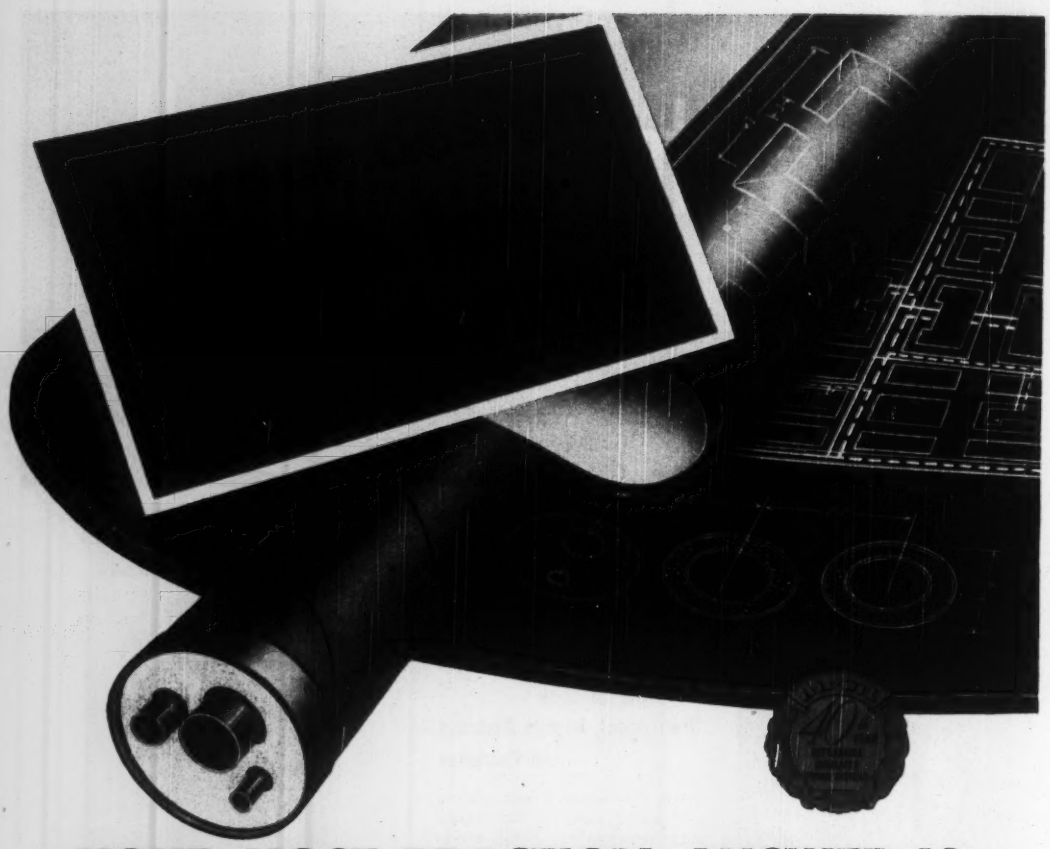

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At your service to supplement the engineering data in these three books is the Link-Belt application engineer who will welcome the opportunity to discuss with you your power transmission problems.

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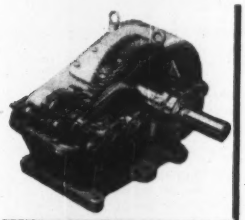
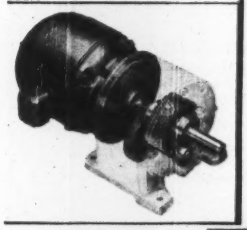
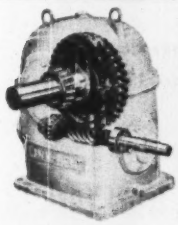




All of these books are available to you. Write your nearest Link-Belt office.

or this



enclosed

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices in Principal Cities. 12,132

Manufacturers and Users of Threaded Components

Here are some reasons why you cannot afford to be without the

UNIFIED AND AMERICAN SCREW THREAD STANDARD B1.1—1949

It covers the unified threads on which agreement has been reached between the Standardization Committees of Great Britain, Canada and the United States and the American Standard Threads.

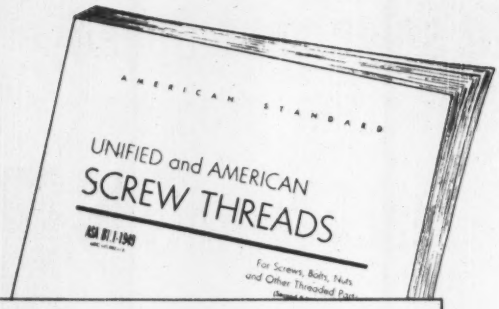
It establishes six new tolerance classes, all related and based on one formula which takes into account the relative influence of the factors of diameter, pitch, and length of engagement. Classes 1, 2 and 3 of the 1935 standard were based on pitch alone.

New tolerance classes are rapidly replacing the old ones.

New threads provide more latitude in design than was possible with old threads.

Unified thread classes are interchangeable with the corresponding national threads despite the fact that American manufacturers will use flat and truncated crests and roots while the British makers will use the rounded form.

If you are using the 1935 Edition you owe it to yourself to replace it with the latest (1949) Revision.



What you will find in This 1949 STANDARD

BASIC DIMENSIONS FOR:

Coarse Thread Series in sizes ¼ in. to 4 inches and for the Fine Thread Series ¼ in. to 1½ inches diameter included in the Unified Screw Threads.

The 8-, 12-, and 16-Thread Series of the 1935 American Standard with an extra fine thread series added.

NEW CLASSES OF FORMULATED TOLERANCES:

1A and 1B—For threaded parts where quick reference and easy assembly is necessary and a liberal clearance is required to permit ready assembly even when the threads are slightly bruised or dirty.

2A and 2B—Suitable for the vast majority of bolts, nuts, screws and similar threaded fasteners because the tolerance and allowances have been carefully determined.

3A and 3B—For applications where closeness of fit, accuracy of lead, and angle of thread are essential.

STEP TABLES AND FORMULAS which furnish data needed for computing limits of size of Special Threads.

DIAMETER—PITCH COMBINATION—of the Unified Coarse and Fine Thread Series, same as those in the 1935 Standard except that the pitch of the ¼ in. coarse thread is now 12, and the ⅛ in.—13 coarse thread and the 1 in.—14 fine thread are optional American Stndards.

OLD CLASSES 2 AND 3—with no allowances and like tolerances for external and internal thread continued without change as American Standard. It is expected that these will be gradually superseded by the new unified classes.

EIGHT APPENDIXES giving the terms and symbols used, the formulas from which values in the tables were derived, tables of old Class 1, and a great deal of other useful information.

$3.00 **(20% Discount to ASME Members)**

Second Edition, incorporating amendment and corrections, Published June, 1950

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The American Society of Mechanical Engineers, 29 W. 39th St., New York 18

C-E REHEAT BOILERS

SEWAREN GENERATING STATION

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

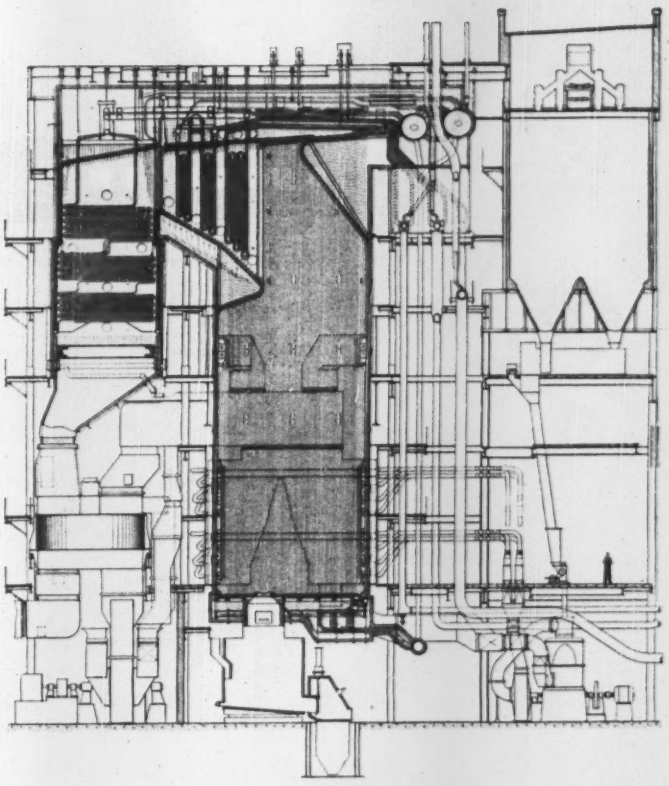
The C-E Unit illustrated here is now in process of erection at the Sewaren Generating Station of the Public Service Electric and Gas Company at Sewaren, New Jersey.

It is a reheat unit designed to serve a 125,000-kw turbine generator operating at an initial steam pressure of 1500 psi at 1050 F reheated to 1000 F.

The unit is of the radiant type with a reheater section located between the primary and secondary superheater surface. A finned tube economizer is located below the rear superheater section, and regenerative air heaters follow the economizer surface.

The furnace is fully water cooled, using closely spaced plain tubes except in the roof section, where finned tubes are employed. It is of the slagging-bottom type, discharging to a quenching hopper.

Pulverized coal firing is employed, using bowl mills and tilting tangential burners. Provision is made to use oil and natural gas as alternate fuels. B-417



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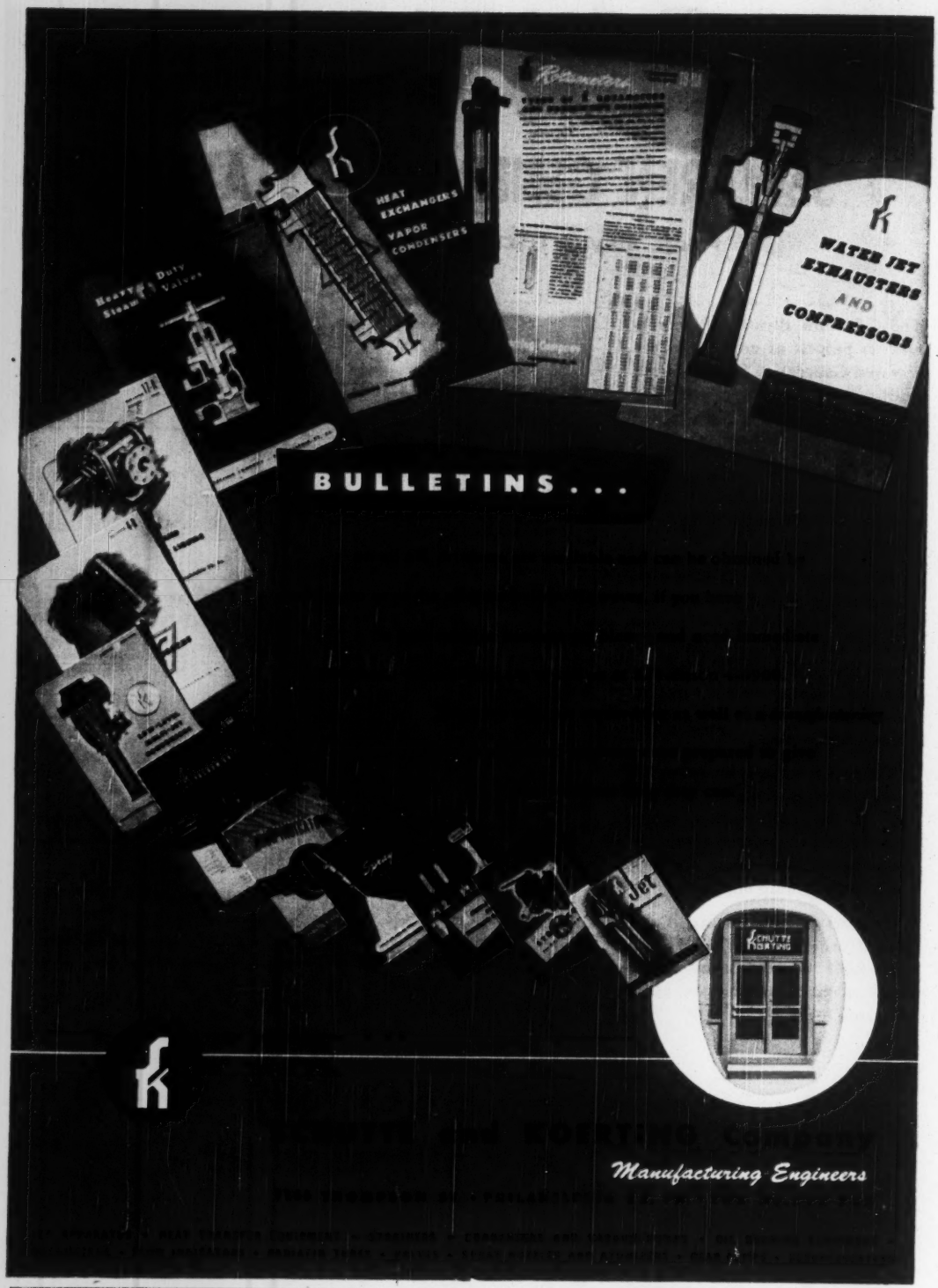
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS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BULLETINS . . .
Manufacturing Engineers

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Let's get down to fundamentals. — There is only one *permanent* way to join pipe — only one joint as strong as the pipe itself — the properly *welded* joint.

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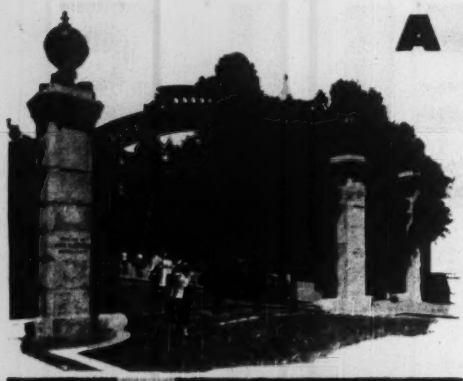

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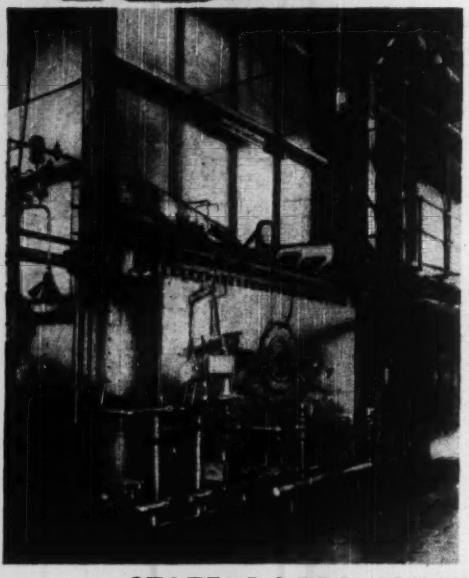
Rates Its New . . .

ERIE CITY 3-DRUM BOILER

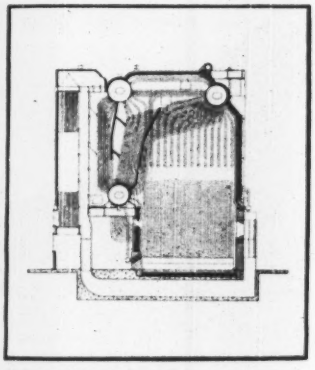
At

87.04% Efficiency



THIS type L Erie City oil fired 3-drum boiler complete with water wall cooling and air pre-heating has a nominal rating of 100,000 pounds of steam per hour and is designed to carry a heating load. It passed the acceptance test on Dec. 27, 1949, slightly better than predicted by Erie City engineers.

- Boiler Heating Surface . . . 9860 sq. ft.
- Water Wall Surface . . . 1260 sq. ft.
- Air Heater Surface . . . 7800 sq. ft.
- Furnace Volume . . . 4100 cu. ft.



STATE BOARD OBSERVES OFFICIAL TEST RUN

Boiler	Erie City Type L3-Drum	Fuel	Bunker "C" Oil.
Object of Test—		Percent CO_2	14.01
Determine capacity and efficiency of boiler.		Temperature gases leaving Boiler	599.2° F.
Date of Test	12-27-49	Temperature gases leaving Air Heater	375.7° F.
Steam Load	103,600 lbs. per hr.	Temperature air leaving Air Heater	355.4° F.
Pressure	133 p.s.i.(g)	Overall efficiency	87.04%

Installation and test under the supervision of Walter S. Leland Co.

Complete test data available upon request.

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

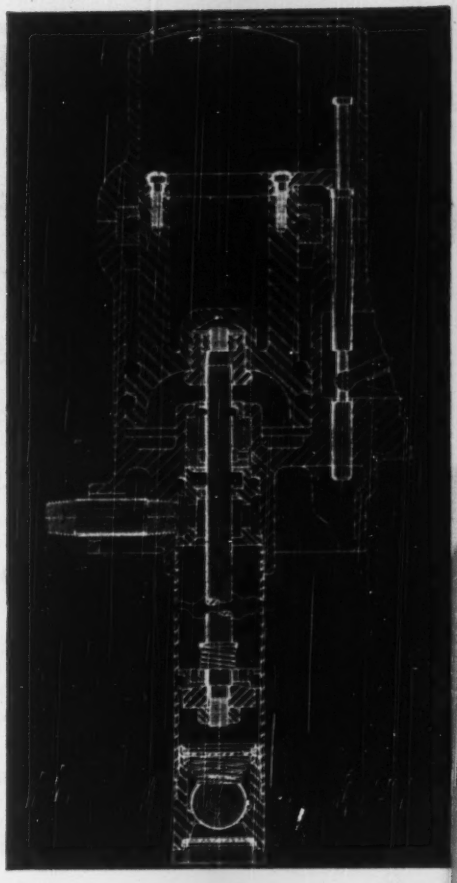
ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

TIP...

FOR THE DESIGNER

No Trap -
No Line Oiler -
and 4,892,900
Strokes With

LINEAR PRECISION MOULDED "O" RINGS



Balcrank, Inc. had a three-fold sealing problem with the new "Jet-Power" pump used for air-operated lubricating equipment. It required a seal capable of withstanding up to 190 psi air . . . moisture varying with humidity conditions . . . and continual friction under high-speed operation.

A severe life cycle test was devised by Balcrank to find a replacement for the unreliable leather seals previously used. During a period of 241 hours and 25 minutes, the pump's air piston made *4,892,900* strokes . . . without benefit of a water trap in the air line or use of the automatic oiler. *Conditions were made extra tough.* LINEAR "O" Rings were used during the test . . . were still sealing perfectly at the end of the run and upon examination showed little or no wear! That was conclusive proof of the superiority of LINEAR "O" Rings for even the most difficult sealing jobs.

LINEAR "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and silastics . . . are available in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes for special uses. For specific help with *your* sealing problem . . . CALL LINEAR.

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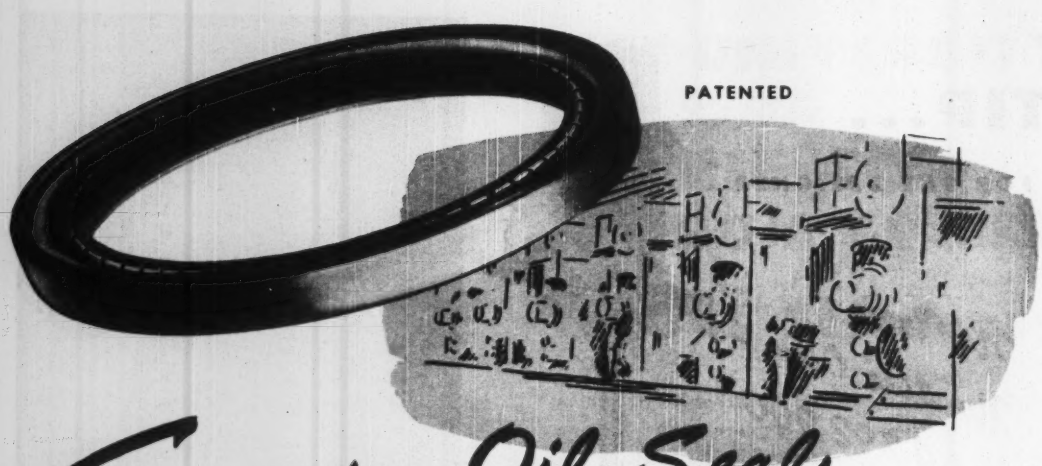
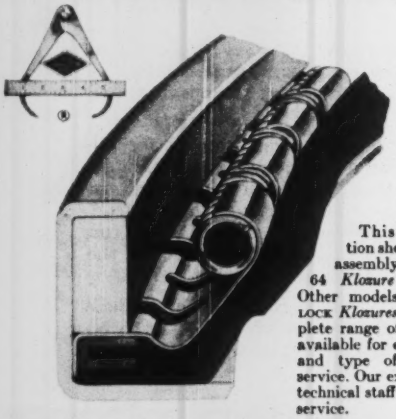


Superior Oil Seals

—For Roll Necks and Other Large Shafts

Model 64 GARLOCK *Klozures* are engineered and designed specifically for service on steel mill roll neck bearings and for other applications involving shafts of large diameter where an unusually rugged oil seal is required.

The metal shell of the Model 64 *Klozure* is reinforced by a heavy, rectangular solid steel inner ring. Positive and accurate positioning of the molded sealing member in the assembly is assured by bonding to its flange a sturdy "U"-shaped steel ring.



This illustration shows sturdy assembly of Model 64 *Klozure* oil seal. Other models of GARLOCK *Klozures* in a complete range of sizes are available for every kind and type of oil seal service. Our experienced technical staff is at your service.

Proper and uniform spring action on the flexible lip of the sealing member is provided by a unique combination spring, consisting of a garter spring and a finger-type spring, so arranged that the finger spring serves as a carrier for the garter spring. This arrangement prevents the garter spring from becoming dislocated during assembly or in service and provides a metal contact surface for the garter spring so it cannot cut into the sealing member thus hampering and ultimately entirely destroying the action of the spring.

Thousands of applications of these Model 64 *Klozures* have proved their effectiveness on roll neck bearings and on other equipment where operating conditions are severe. If you have a tough sealing job on a shaft 8″ diameter or larger, this oil seal warrants your careful consideration.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Garlock KLOZURE*

*REG. U. S. PAT. OFF.

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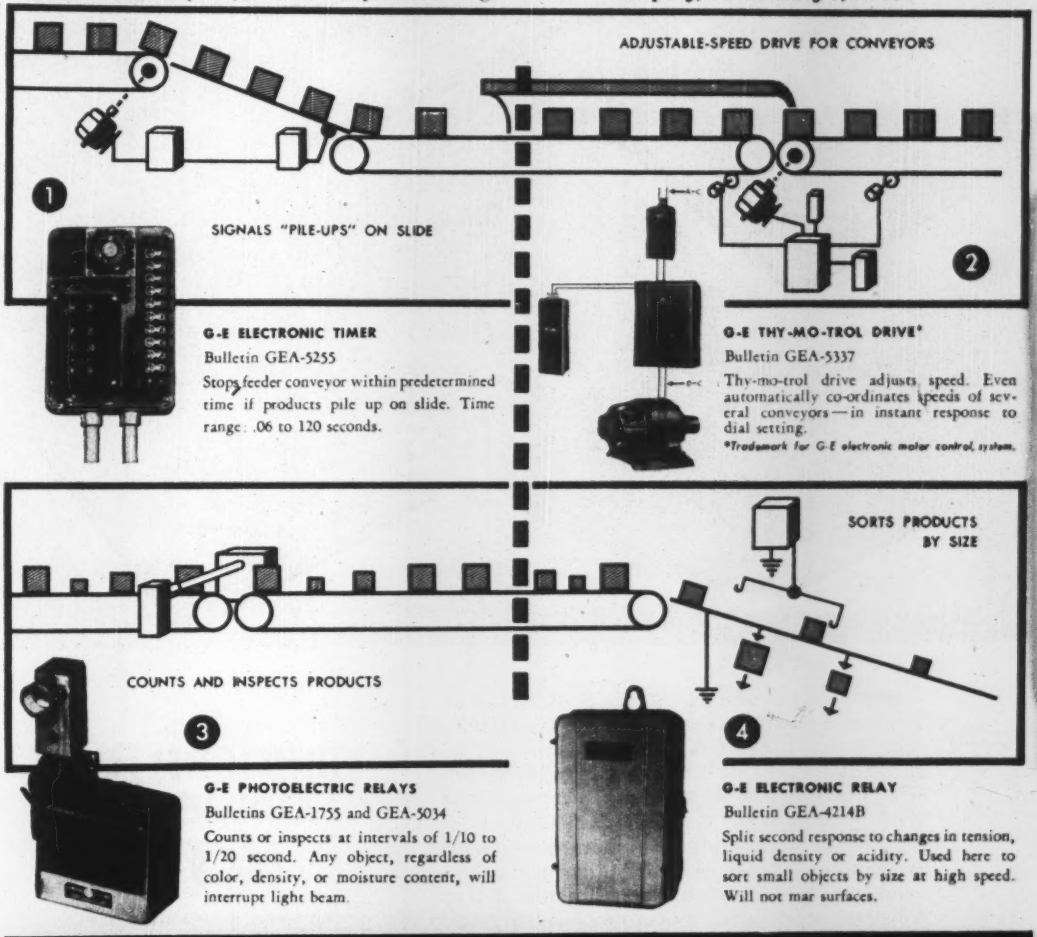
Want to speed a process? Cut costs? Count? Sort? Inspect quantities of tiny parts rapidly? Adjust machine speed according to job? Accurately time processes? Regulate tensions in response to slight variations? Control motors automatically according to time, liquid level, temperature, or density? Want to do these jobs quietly, without frequent servicing?

You want G-E electronic devices!

See what they do on Process X—then plan how they can go to work for you. The nearest G-E sales engineer will be glad to help you select the right type for your applications; or write for bulletins for more information. ***Apparatus Dept., General Electric Company, Schenectady 5, N. Y.***



G-E ELECTRONIC TIMER

Bulletin GEA-5255

Stops feeder conveyor within predetermined time if products pile up on slide. Time range: .06 to 120 seconds.

G-E THY-MO-TROL DRIVE*

Bulletin GEA-5337

Thy-mo-trol drive adjusts speed. Even automatically co-ordinates speeds of several conveyors—in instant response to dial setting.

*Trademark for G-E electronic motor control system.

G-E PHOTOELECTRIC RELAYS

Bulletins GEA-1755 and GEA-5034

Counts or inspects at intervals of 1/10 to 1/20 second. Any object, regardless of color, density, or moisture content, will interrupt light beam.

G-E ELECTRONIC RELAY

Bulletin GEA-4214B

Split second response to changes in tension, liquid density or acidity. Used here to sort small objects by size at high speed. Will not mar surfaces.

GENERAL ELECTRIC

Increase knowledge of electronics with the G-E MPA Electronics Training Course. Twelve lessons for $150. Write now for information.

Close-up of tie plate and felt pad. The facilities of Grand Central Terminal are shared by The New York Central and the New York, New Haven & Hartford, two of America's great railroads, serving our five plants.

● Passengers who use the famous Grand Central Terminal in New York City never know that they are riding on felt, but such is the case. Felt pads are installed under the tie plates that hold the rails to the ties. Felt is used here to lessen the transmission of vibration to the structure of the Terminal, which has tracks on two levels, one above the other. In this application, felt probably meets its most severe test in vibration control. Another function of the felt is to reduce noise. Felt by American serves perfectly here, and lasts amazingly long, even under loads running as high as 25,000 pounds on each electric locomotive driving wheel. Replacements have been due chiefly to changes in rails and in tie plate design—the felt in some cases actually lasts as long as the steel rails!... If you have a problem in vibration control, get in touch with American Felt or any of its Sales Offices.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE RD., GLENVILLE, CONN.—ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

Let us help you solve your SPEED REDUCER PROBLEMS

Problem:
A gear unit to transmit calculated load of 100 HP from a 125 HP, 1750 RPM motor to induced draft fan at 290 RPM, continuous 24-hour service.
Solution:
Equivalent HP = 100 x 1.50 (service factor) = 150
Ratio = 1750 ÷ 290 = 6.03:1
Tabulated data in Bulletin No. 449 shows SR-137 unit to be correct size for this application.

Farrel speed reducers have incorporated in them the experience gained in the solving of innumerable problems requiring considerable pioneering in gear engineering. The result is a wide range of types (a few of which are illustrated here), that are standard in principal features, but adaptable in critical detail.

All units are supplied with precision gears, generated by the famous Farrel-Sykes process for smooth, quiet, efficient power transmission; shafts and bearings factored to safeguard against interruption of vital processes; gear cases proportioned to withstand repeated heavy peak loads; joints sealed to prevent entrance of dust and dirt.

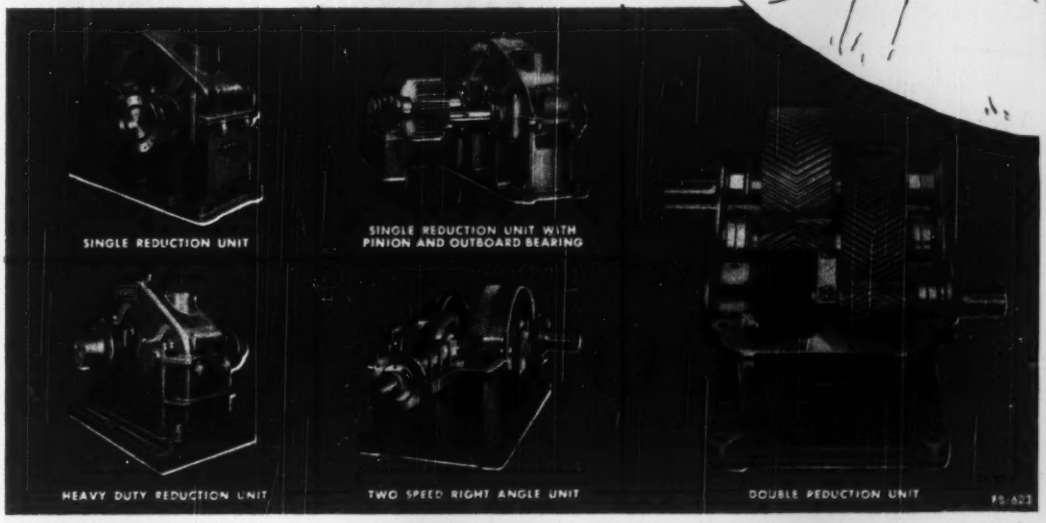
But, that is not all. Without sacrificing the advantages of general standards, the design of these units permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility has resulted in the solution of innumerable application problems.

Write for further details. Ask for a copy of Bulletin 449 —no cost or obligation.

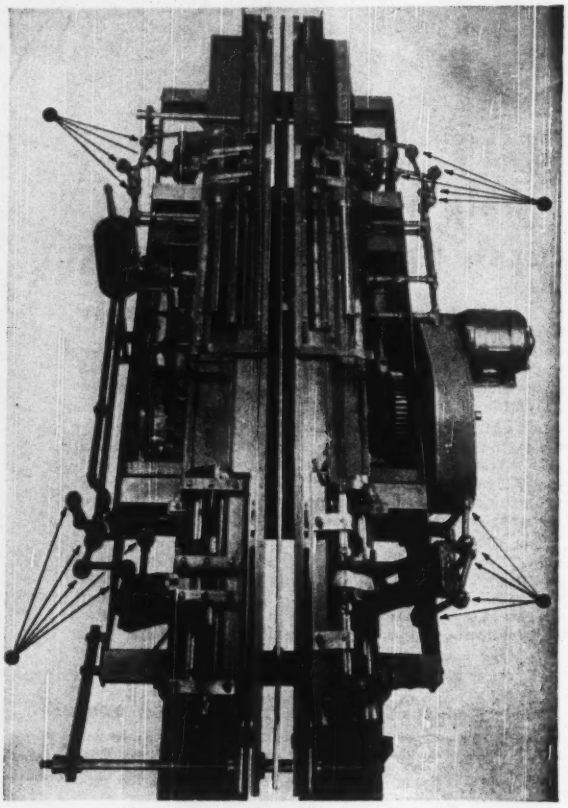
FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y., *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, Tulsa, Houston, New Orleans

Farrel-Birmingham®


SINGLE REDUCTION UNIT
SINGLE REDUCTION UNIT WITH PINION AND OUTBOARD BEARING
HEAVY DUTY REDUCTION UNIT
TWO SPEED RIGHT ANGLE UNIT
DOUBLE REDUCTION UNIT
FB-623

FLEXIBLE JOINT ADAPTABILITY for all services



This Can-Flaring machine uses Barco (extra heavy) Swivel Joints to keep its fluid lines flexible.

Providing such flexibility is no unusual job for Barco Joints. They perform many services on a wide variety of machines and fluid conveying systems, both simple and complex. Barco Joints are made to withstand hydraulic pressures of 2500 pounds. They are unique in their ability to absorb shock and misalignment strains, due to a combination ball and swivel action.

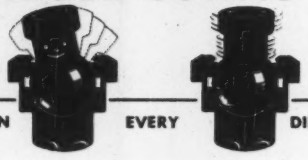
Throughout the last 41 years, Barco engineers have solved thousands of problems relating to flexible connections. Their experience and technical skill are at your disposal. Write Barco Manufacturing Co., 1807K Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal, Canada.

CAN-FLARING MACHINERY USES BARCO SWIVEL JOINTS (EXTRA HEAVY)

BARCO FLEXIBLE JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.



"MOVE IN EVERY DIRECTION"

Hi-Test KEWANEE

FOR POWER and PROCESS STEAM

All-welded Portable with firebox for refractory lining and fuel-conserving 2-pass tubes. A Q-u-i-c-k Steamer. 6 sizes, 50 to 150 H.P., 125 and 150 lbs. W.P.

80 Years Boilermakers

WAITE Dept. 89-M10 for 6" scale with pipe diameter markings

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS

MECHANICAL ENGINEERING

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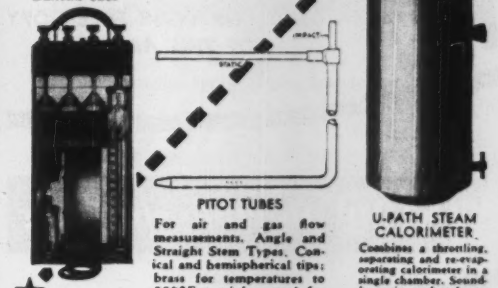
YOU'RE SURE OF PROPER COMBUSTION with ELLISON INSTRUMENTS !

PORTABLE GAS ANALYZER

Accurate, easy-to-use Combustion Testing Set is equipped for analysis of CO_2, O_2 and CO, complete with flue gas thermometer. Described in Bulletin 120.



PORTABLE GAS ANALYZER

PITOT TUBES

For air and gas flow measurements. Angle and Straight Stem Types. Conical and hemispherical tips; brass for temperatures to 500°F.; stainless steel for temperatures to 1000°F. Described in Bulletin 9-F.

U-PATH STEAM CALORIMETER

Combines a throttling, separating and re-evaporating calorimeter in a single chamber. Soundly engineered and constructed. Ask for Bulletin 118.

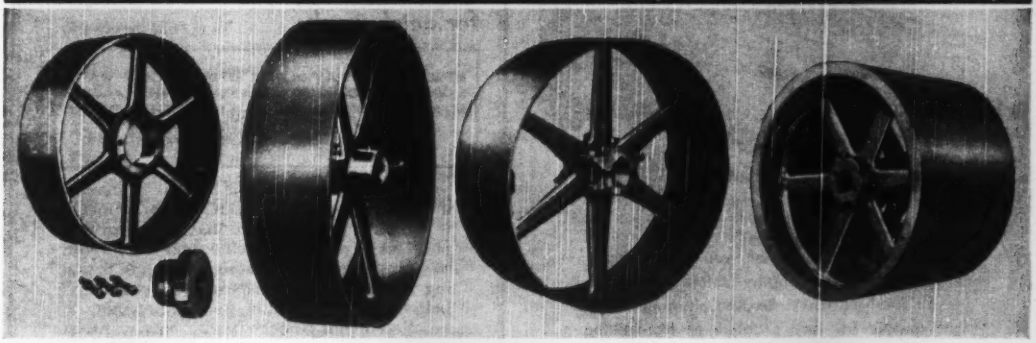
ELLISON DRAFT GAGE CO.

214 W. KINZIE ST. Since 1896 CHICAGO 10, ILL.

THE ELLISON LINE ALSO INCLUDES:

Dial Draft Gages—Bell Type - Inclined Draft Gages—Portable Inclined Vertical Tube Gages - Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube - Saturator Gages U Gages—Stationary and Portable - Air Filter Gages—Dial and Inclined Tube Types - Pitot Tubes - U Path Steam Calorimeters Portable Gas Analysers—Orsat Type

PULLEYS (CAST IRON)... ALL TYPES AND SIZES



"Sure Grip" STOCK PULLEYS—Cast iron with crown or straight face. One-piece flanged and split tapered hub permits easy installation and removal from the shaft. Four hubs take care of bore range from 1/2" to 2-7/16". Available for immediate delivery in 2-1/2" to 12" face width in 4" to 36" outside diameter.

STANDARD PULLEYS—Solid or split through rim and hub, with straight or standard crowa face, accurately bored and carefully balanced. Diameters 2" to 120"—face width from 2" to 60".

SPECIAL PULLEYS—Flexible pattern set-up and modern foundry facilities permit us to make made-to-order pulleys without delay.

Write for Detailed Information.

Power Transmission Equipment Engineers and Manufacturers Since 1857.

T. B. WOOD'S SONS COMPANY, CHAMBERSBURG, PENNA.

Branches: Boston, Mass., Newark, N. J., Dallas, Tex., Cleveland, O.

Write today!

FOR YOUR FREE COPY OF THIS HANDY

STOW *flexible shafting*

TORQUE CALCULATOR

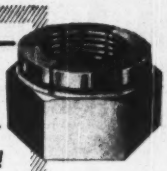
Gives you the information you need simply, quickly. Eliminates lengthy calculation. And, just as surely, STOW flexible shafting is the right answer for any problem of transmitting power through a curved path, around obstacles, or from one level to another.

Write today, on your company letterhead, for your FREE, handy flexible shafting torque calculator. And remember STOW—first in flexible shafting since 1875.

STOW MANUFACTURING CO.
52 SHEAR ST.
BINGHAMTON, N. Y.

A fastener AIN'T, if—
it works loose.

The "FLEXLOC" IS—
because it won't!



FLEXLOC

ONE-PIECE, ALL-METAL
STOP- and LOCK-NUT

Its "chuck-like," resilient locking segments lock the "FLEXLOC" securely in any position on a threaded member with a controlled, uniform and dependable torque.

Tough applications demonstrate that the "FLEXLOC" positively "won't work loose", yet it can be removed easily with a wrench when desired. Because it is all-metal, temperatures as high as 550°F. hold no terrors for the "FLEXLOC."

The "FLEXLOC" has plenty of tensile . . . can be re-used many times . . . has therefore a long, effective life.

Write for further information and free samples.

See us at Booth 2434, Convention of National Metal Congress and Exposition, Chicago, Oct. 23 to 27.

SPS STANDARD PRESSED STEEL CO.
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MECHANICAL ENGINEERING
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BUSINESS OPPORTUNITIES MANUFACTURING FACILITIES
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HELP WANTED POSITIONS WANTED
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If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—*use a classified advertisement in the Opportunities Section.*

RATES

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

No. 44—Product of Northern Electric Company Chicago 25, Illinois

This Northern Electric Blanket is "Just what the Doctor ordered" for restful slumber, undisturbed by temperature changes or cumbersome coverings. Actuated by Chace Thermostatic Bimetal, its Underwriters' approved thermostat maintains the warmth you want within one degree all through the night.

Pre-setting determines the travel of the bimetal actuating element, regulating time of the heating cycle. When the circuit is closed, current is supplied to the blanket heating element and to a heater coil mounted near low-expansive side of the bimetal. Thermal response of the contact-carrying bimetal pulls it away from a fixed contact, breaking the circuit. As the bimetal cools it returns toward closed position, where it enters the field of a permanent magnet which closes the circuit with a snap action to begin another heating cycle.

Chace Thermostatic Bimetal is available in strips, coils, random long lengths, completely fabricated elements or sub-assemblies ready for installation in your product. You'll find the Chace Application Engineer extremely helpful in design problems involving temperature-responsive devices. We invite you to take advantage of our consultation service.

W. M. CHACE CO.
Thermostatic Bimetal
IT BENDS WITH THE HEAT
1619 BEARD AVE., DETROIT 9, MICH.

TRU-LAY Push-Pull is precision-made. Therefore it . . .

. . . is positive in action as a steel rod, yet flexible as wire rope

. . . transmits action over long or short lengths, with few or many bends

. . . will operate while flexing, with practically no lost motion

. . . is made in capacities up to 1000 pounds input

. . . is designed for long life—a machine part—not a flimsy gadget

MAIL THE COUPON BELOW

(to our Detroit Office) for bulletin of information about TRU-LAY Push-Pull.

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•
1119 Santa Fe Avenue, Los Angeles 21
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Bridgeport, Conn.

ACCO
AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

Please send me copy of descriptive bulletin DH-87-M-1.

Name_____
Company Name_____
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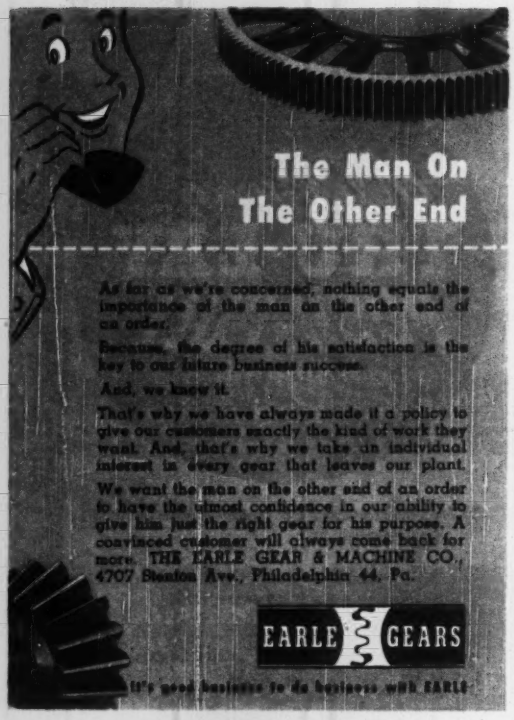
The Man On
The Other End
As far as we're concerned, nothing equals the importance of the man on the other end of an order.
Because, the degree of his satisfaction is the key to our future business success.
And, we know it.
That's why we have always made it a policy to give our customers exactly the kind of work they want. And, that's why we take an individual interest in every gear that leaves our plant.
We want the man on the other end of an order to have the utmost confidence in our ability to give him just the right gear for his purpose. A convinced customer will always come back for more. THE EARLE GEAR & MACHINE CO., 4707 Stenton Ave., Philadelphia 44, Pa.
EARLE GEARS
It's good business to do business with EARLE

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OIL AND GAS BURNING EQUIPMENT

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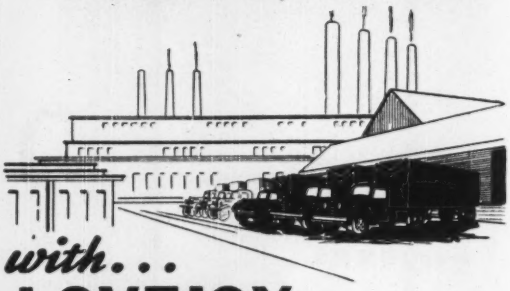
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

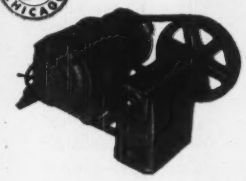
MPB makes more than 50 types and sizes of miniature ball bearings
BEARINGS, Ball, miniature. Standard and Special for application in precision mechanisms to minimize friction and wear. High load capacity in minimum space. Light in weight. Specify MPB for shock loads, continuous operation, extreme temperature ranges and delicate responsiveness. Special designs and complete engineering service for your application. Write for catalog M.
MPB MINIATURE Precision BEARINGS
INCORPORATED
KEENE, NEW HAMPSHIRE, U.S.A.

YOU CAN GET MORE WORK FROM YOUR PRESENT EQUIPMENT



with...

LOVEJOY VARIABLE SPEED PULLEYS



Old machines formerly limited to a few production operations can easily be modernized for additional capacities by installing the dependable LOVEJOY VARIABLE SPEED PULLEY. These sturdy, economical speed pulleys give machines many additional advantages by increasing machine performance and productivity. The LOVEJOY VARIABLE SPEED PULLEY is available in 8 different sizes, ranging from fractional H.P. to 8 H.P., and with speed ranges up to 3 to 1. Speeds are infinitely variable while running.

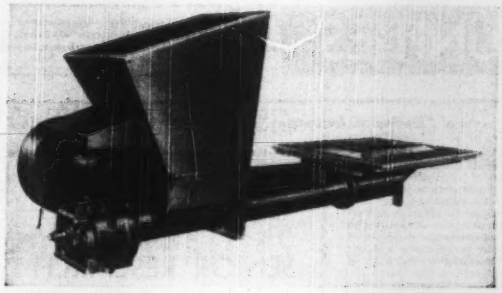
Regardless of how efficient your fixed speed machines are, you can process materials quicker, better and at less cost by installing LOVEJOY VARIABLE SPEED PULLEYS. These highly efficient pulleys will make your production schedule changes almost instantaneous because they compensate for variation and density of parts—temperature—humidity and speed variations of operators.

Complete catalog showing wide variety of applications is yours free. Write:

LOVEJOY FLEXIBLE COUPLING CO.

5032 W. Lake St., Chicago 44, Ill.

Also Mfrs. of Lovejoy L-R Flexible Couplings and Lovejoy Universal Joints



BUILT AND BACKED BY BROWNELL

This is the Brownell Type "C" wormfeed stoker. Every detail of its construction reveals the knowledge and integrity for which the Brownell name is famous.

The transmission is a husky, precision-built mechanism with 3-speed anti-clash gearshift, automatic safety stop switch, and thorough lubrication. The hopper is heavy, corrosion-resisting sheet metal on a steel plate base. The feed worm is cast alloy steel. The furnace ironwork consists of heavy, air-cooled sectional tuyeres and dead-plates or side-dump grates.

A gas-repellant valve prevents blow-back of smoke and fumes. Automatic air volume control is optional at extra price. Eleven sizes are available with ratings of 45 to 258 boiler h.p. *Ask for fully descriptive bulletin and data.*

THE BROWNELL COMPANY

446 N. FINDLAY STREET — DAYTON 1, OHIO

Repair CRACKED CONCRETE FLOORS

When your concrete floors develop cracks, ruts, shallow holes or rough spots, repair them with Smooth-On No. 7B Quick Floor Patch Cement. It comes in powder form ready to mix with water. Simply apply Smooth-On No. 7B as you would plaster. Smooth-On No. 7B expands slightly as it hardens, insuring a secure, tight fit. You get an iron-hard surface that can take the punishment of heavy traffic. Order Smooth-On No. 7B Quick Floor Patch Cement in 1, 5, 20, or 100 lb. size.

FREE *Folder and Repair Handbook*

Write for your copy of the illustrated Smooth-On Quick Patch folder and the famous Smooth-On Repair Handbook. Pocket size, 40 pages, 170 simple illustrations. Shows how to make many time-saving, money-saving repairs.

SMOOTH-ON MFG. CO., Dept. 56
570 Communipaw Ave., Jersey City 4, N. J.

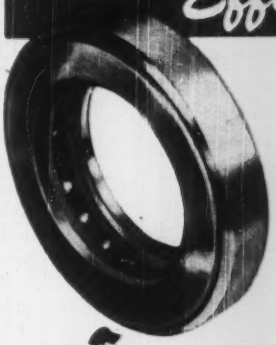
50-549

Do it with **SMOOTH-ON**
QUICK FLOOR PATCH CEMENT

Aetna BEARINGS — YALE LIFT TRUCKS

United Since 1935

FOR GREATER MATERIALS HANDLING *Efficiency!*



All industry knows Yale Lift Trucks as rugged workers that cut costs, speed production, handle all kinds of materials in volume—faster, safer, more efficiently.

Important contributors to their efficiency are the rugged ball thrust bearings in the trailing axle and wheel assembly—bearings specially designed to

meet the high load capacity, precision smoothness and long, trouble-free performance required in this tough application—bearings which Aetna has proudly supplied for over 15 years.

Improved performance, longer life and minimized maintenance are advantages which come to any hard working equipment when Aetna bearings lend a hand. Our engineers are ready and willing to work with you at any time.

AETNA BALL AND ROLLER BEARING COMPANY
4600 SCHUBERT AVENUE · CHICAGO 39, ILLINOIS

Aetna

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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For Mechanical Design and Engineering Studies in connection with Electric Utility work. Should have 15 years' experience in similar work.

Write to: Mechanical Engineer, Pennsylvania Power & Light Company, Allentown, Pennsylvania.

MECHANICAL DESIGN ENGINEERS

Experienced in design and development of heavy mechanical equipment, mining machines and tractors. Work includes design, layout and detailing of heavy machinery. Send complete record with photograph. Location, medium-sized city in Western United States.

Address CA-3329, care of "Mechanical Engineering."

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Physicists and Engineers with advanced experimental and theoretical experience in

- **Nuclear Technology**
- **Solid State Physics**
- **Physical Metallurgy**
- **Power Plant Components**

are desired for research and development work on direct contract with the Reactor Division of the Atomic Energy Commission.

These positions offer unique opportunities for working with a highly trained group of scientists and for participating in theoretical and experimental studies in nuclear reactor technology. The laboratory is located in the Los Angeles area.

Please write to:

NORTH AMERICAN AVIATION, Inc.

Attention: Personnel Manager

ATOMIC ENERGY RESEARCH DEPARTMENT

12214 South Lakewood Blvd.
Downey, California

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CHIEF DRAFTSMAN

Graduate engineer, with knowledge of mechanical, structural and electrical construction with at least 10 years' experience in same or similar position. Prefer man now employed in some phase of steel industry, with proven supervisory ability. Give age, qualifications and salary requirements in first letter.

Address CA-3321, care of "Mechanical Engineering."

MECHANICAL ENGINEER

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Long Established
New England Concern
Manufacturing
Textile Finishing
Equipment with
New Products
in Production
and Others in
Design Offers
Worthwhile Position
and Growth Future
to Creative
Engineer

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Send full Resumé in Confidence

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POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

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- Radar
- Fire Control
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- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

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AEROPHYSICS LABORATORY
Box No. H-4
12214 South Lakewood Blvd.
Downey, California

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

Three Pages of "OPPORTUNITIES" This Month . . . 110-112

Graduate Engineers

GOOD OPPORTUNITIES

for

METALLURGICAL RESEARCH ENGINEERS—M.S. or Ph.D. in Metallurgical Engineering. Must have at least a few years research experience and be interested in research and development in materials of construction for the chemical industry.

MECHANICAL RESEARCH ENGINEERS M.S. or Ph.D. in M.E. for research in mechanical engineering with emphasis on automatic special machinery, machine design, or machine components. Must be outstanding technically and with at least a few years research experience.

POWER ENGINEERS—must have 8 to 12 years' experience in operating, testing, and maintaining power plant equipment, supervising power plant operations, making cost and evaluation studies, heat balance work, power cost accounting and the selection and installation of power plant equipment. Must be graduate.

MATERIALS HANDLING ENGINEERS—must have 8 to 12 years' broad experience with operation, design and uses of all types of materials handling equipment. Desire familiarity with chemical equipment and its operation. Also interested in engineers with specific experience in bulk materials handling. Must be graduate.

HEATING & VENTILATING DESIGNERS—must be graduate with at least 5 years' industrial heating and ventilating design experience or at least 12 years' practical industrial design experience in this field.

HEATING & VENTILATING ENGINEERS—must be experienced graduate engineers capable of handling field and office problems in heating, ventilating and air conditioning design including economical evaluation of methods.

PROCESS ARRANGEMENT & PIPING DESIGNERS—must be graduate with at least 5 years' experience in industrial design and chemical plant design or at least 12 years' practical industrial design experience in this field.

PROCESS ENGINEERS—must be graduate with minimum of 8 years' industrial plant design experience at least 3 years of which have been in responsible charge of design work. Field experience desirable. Must have experience in design calculations, equipment design and plant arrangement in the chemical field.

Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific.

ALL INQUIRIES WILL BE CONSIDERED PROMPTLY AND KEPT CONFIDENTIAL.

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Wilmington 98, Delaware

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Openings for experienced design and production engineers. Must have had design experience in mechanical, electrical, or electronic aspects of small intricate mechanisms. Design of servo-mechanisms, communications equipment, small power tools, sewing machines, vacuum cleaners, business machines, etc., is the type of experience desired. A degree in mechanical or electrical engineering is preferred but is not required. Give full details of education, experience, and personal history. Permanent positions with well-established firm located in central New York State.

Address CA-3259, care of "Mechanical Engineering."

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B.S. or advanced degree with 5 to 10 years' experience in design and development of miscellaneous mechanical apparatus such as farm implement, materials handling, packaging and special automatic machinery fields. This is a position of high potential with a 105-year-old company located in Michigan. Requires high creative design ability and qualities of leadership. Submit full details in confidence.

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Address CA-3315, care of "Mechanical Engineering."

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America's fastest growing and leading manufacturer of automatic control equipment has a number of attractive openings for electrical and mechanical engineers with research, design or development experience in the following areas: Electronics, Servo Mechanisms, Small Electro-Mechanical Devices, Relays, Electro Magnetics and related activities. Excellent opportunities for advancement. Attractive salaries. Location: Minneapolis. Write giving full particulars to B. J. Walker, Employment Manager.

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MECHANICAL ENGINEER or METALURGIST—Familiar with light metal fabrication for production control work by manufacturer of extruded and rolled magnesium and aluminum alloys. Write stating qualifications, experience and salary required. White Metal Rolling & Stamping Corp., 80 Moultrie St., Greenpoint, Bklyn, N. Y.

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SALES ENGINEER—compressors and centrifugal pumps for heavy industrial and power plant service, New York area. M.E. graduate preferred. Salary commensurate with ability and experience. Submit complete record and photo with reply. Address CA-3320, care of "Mechanical Engineering."

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MECHANICAL-CIVIL ENGINEER—25 years' experience design, construction, operation metallurgical and chemical plants. 10 years in responsible charge of such work as chief engineer and project manager. Recently completed foreign contract on a general engineering project including a steam power plant, dam, harbor development, and other related work as project manager. Available October 1, for similar position anywhere U.S.A. Address CA-3289, care of "Mechanical Engineering."

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MECHANICAL ENGINEER—Graduate, ASME, age 27, married. 3 years' plant engineering in chemical industry, 3 years' engineering officer in air corps. Desires permanent position in chemical or allied industry, location in S. E. preferred. Address CA-3312, care of "Mechanical Engineering."

MECHANICAL ENGINEER—27, single, veteran, M.S. available Jan., 1½ years' design exp. Courses in stress analysis, design, Diesels, vibrations, management. Desires position in production, development, research, design, engines, heat transfer. Will relocate. Address CA-3314, care of "Mechanical Engineering."

MECHANICAL ENGINEERING GRADUATE—U. of Wisconsin, upper 20% of class. Interested in design and development work. Three years' experience in machine design, design of pressure vessels and piping, plus service and field assignments. Location in Wisconsin preferred. Address CA-3325, care of "Mechanical Engineering."

NEW ENGLAND MANUFACTURERS OF MECHANICAL-ELECTRICAL PRODUCTS—Registered Engineer available, 15 years' experience design and production problems, small machines, and electrical and magnetic items and machine tools, project engineer and manufacturing supervisor. Address CA-3327, care of "Mechanical Engineering."

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It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

ENGINEERS AND EXECUTIVES—This confidential service for outstanding men who desire positions paying $5,000 to $40,000 will develop preliminary negotiations with reputable organizations without risk to present position. For complete details, send experience record and expected salary range. Tomsett Associates, 1205-1 Berger Bldg., Pittsburgh 19, Pa.

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection, communicate with the undersigned. We offer the original personal employment service (40 years' recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 115 Dun Bldg., Buffalo, N. Y.

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JIRA THAYER JENNINGS
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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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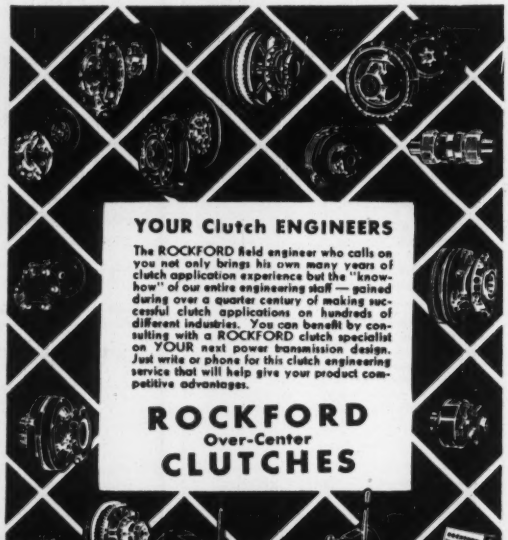

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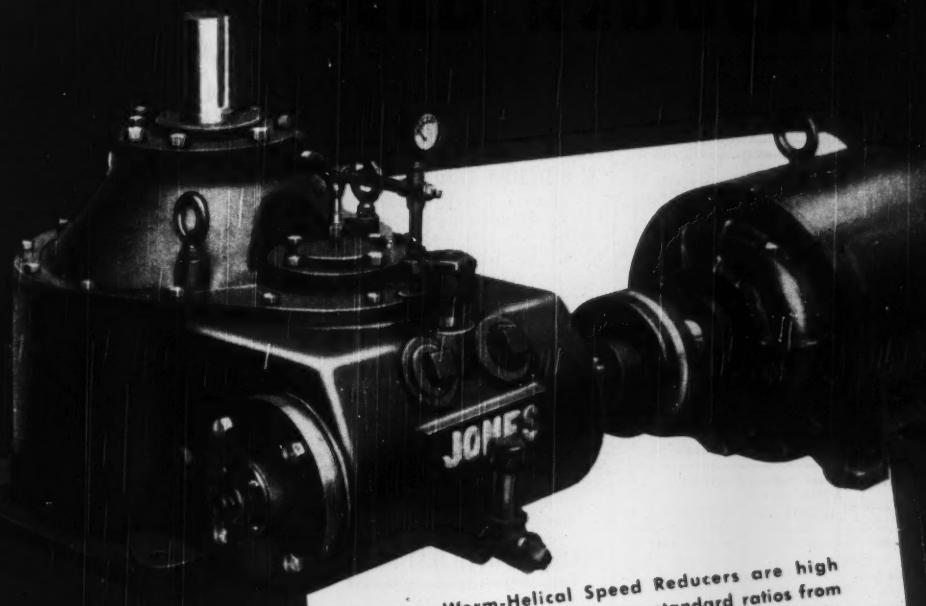

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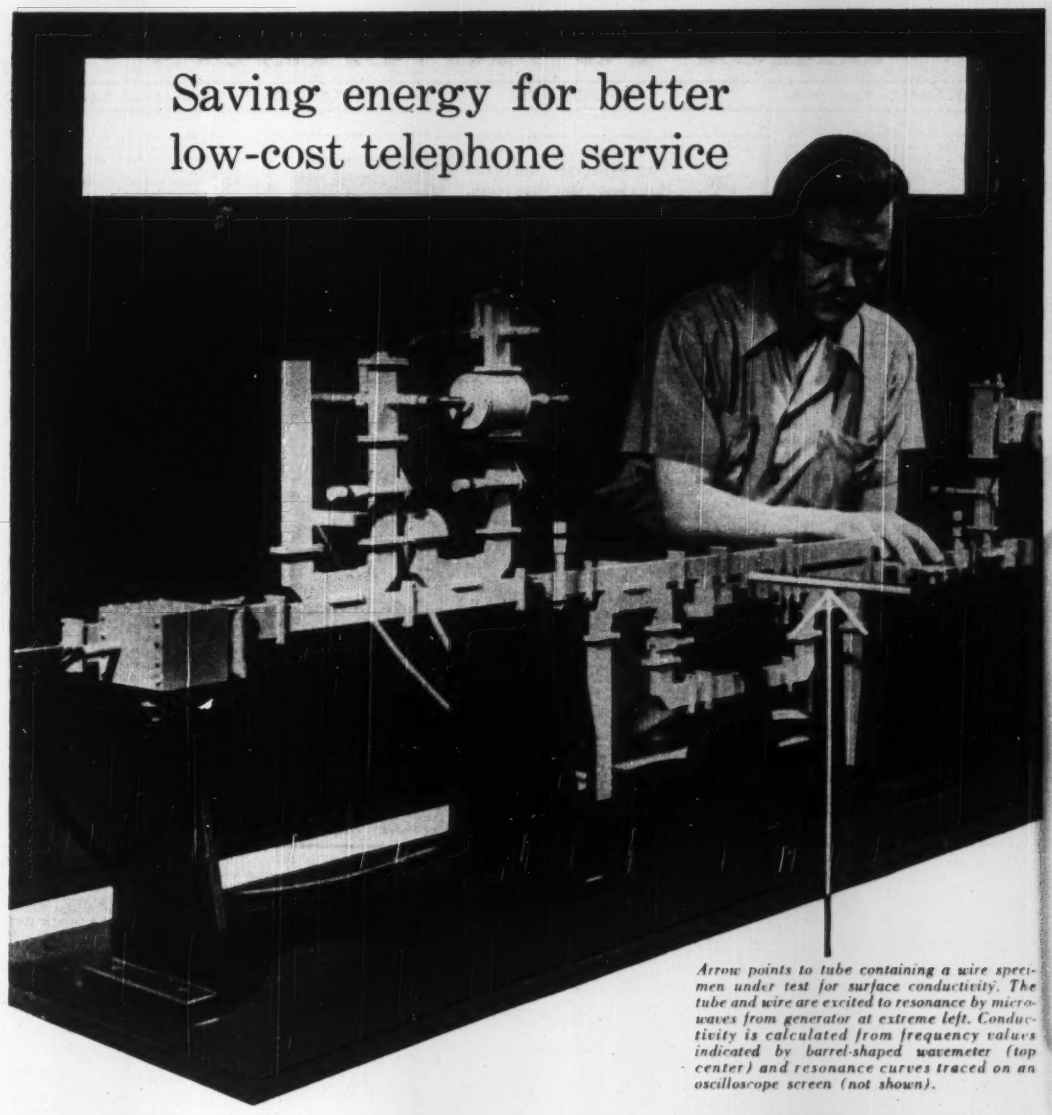

Arrow points to tube containing a wire specimen under test for surface conductivity. The tube and wire are excited to resonance by microwaves from generator at extreme left. Conductivity is calculated from frequency values indicated by barrel-shaped wavemeter (top center) and resonance curves traced on an oscilloscope screen (not shown).

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves initial high conductivity for many months.

Energy saved *inside* a microwave station is available for use in the radio-relay path *outside*. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

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MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

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Name _____ Title _____

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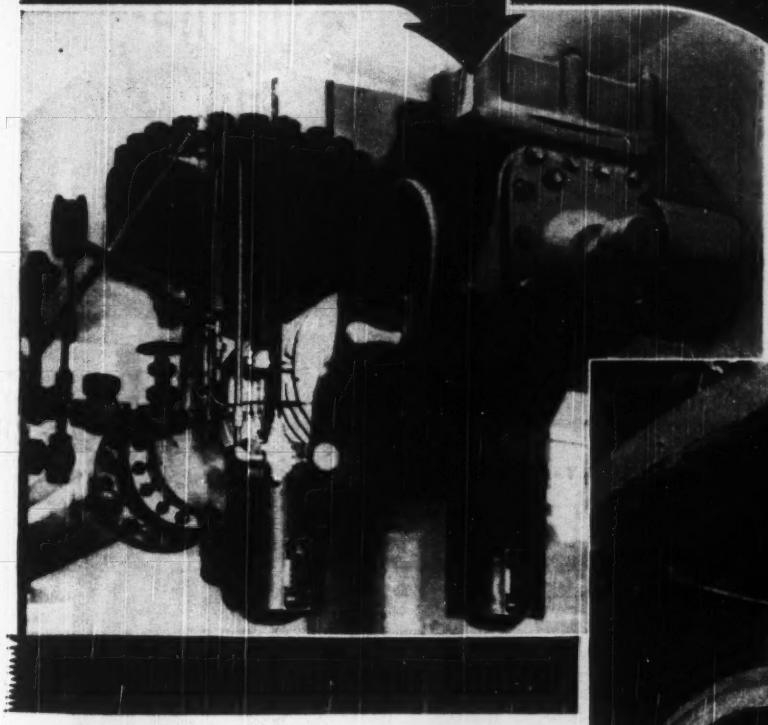
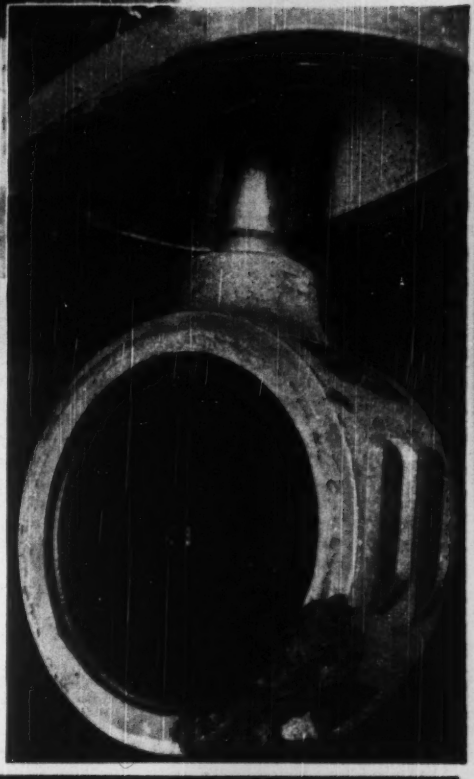
LIMITORQUE PREVENTS





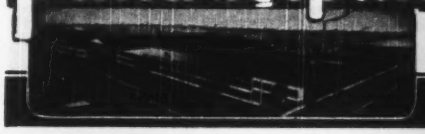
LimiTorque Control gives absolute assurance against improper seating, by means of a positive safety overload mechanical torque cut-out. If obstruction is met in closing valve, the torque switch becomes operative and disconnects the motive power.

Philadelphia LimiTorque Control will efficiently open and close globe, gate, butterfly and plug valves etc. by the "push of a button" at a remote or nearby control station. Handwheel is provided for rapid manual operation if necessary.

LimiTorque is readily adapted to any make of valve. Furthermore, it can be installed on existing equipment. Any available power source for operation may be utilized, electricity, oil, gas, water, air. LimiTorque can be supplied by any valve manufacturer.

Send for Catalog — *Our LimiTorque Catalog is yours upon request. Please write on your business letterhead.*

Philadelphia Gear Works, INC.

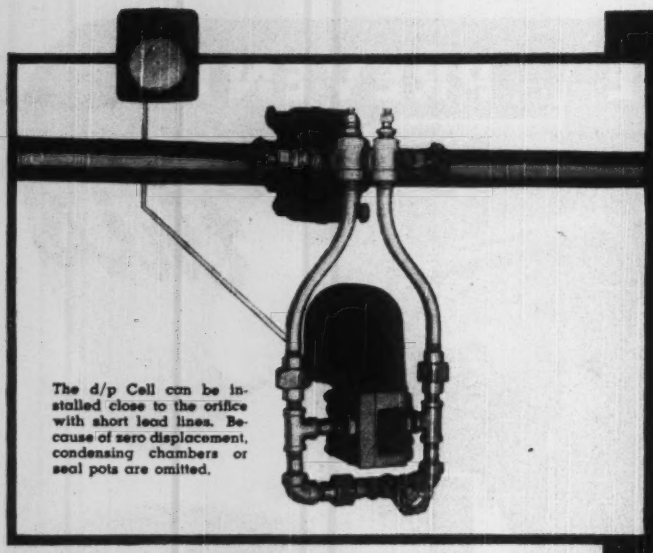


ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers – LimiTorque Valve Controls



The d/p Cell can be installed close to the orifice with short lead lines. Because of zero displacement, condensing chambers or seal pots are omitted.

Simpler Flow Measurement

in the palm of your hand

NEW • REVOLUTIONARY • MERCURY-LESS

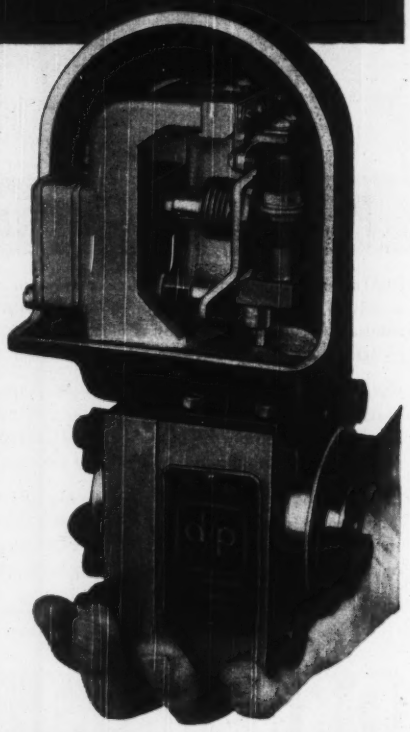
FOXBORO

DIFFERENTIAL PRESSURE CELL

Now you can simplify many troublesome flow problems . . . especially those where corrosion is a factor or the use of mercury is objectionable. This unique flow measuring device is accurate, easily calibrated, and widely applicable, and it weighs only 20 lbs. The Foxboro d p Cell offers a combination of advantages that no other type of flow measurement can duplicate.

The Foxboro d/p Cell operates on the highly-accurate force-balance principle, transmitting flow measurement to remote, conveniently-located pneumatic receiving instruments (indicating, recording, controlling). Range: 80 in. to 800 in. H_2O. Working pressures: 750 psi and 1500 psi.

Get all the facts about this revolutionary new device for the measurement of liquid, steam, gas or air flow. Write for Bulletin 420. **The Foxboro Company, 182 Neponset Ave., Foxboro, Mass., U. S. A.**



UNIQUE ADVANTAGES

1. Type 316 Stainless Steel Construction.
2. Uses no mercury.
3. Essentially zero displacement — no need for condensing chambers on steam measurement or seal pots on liquid measurement.
4. Immediate, unfailing response to differential pressure changes.
5. Positive overrange protection.
6. Easy zero and range adjustments.

FOXBORO RECORDING · CONTROLLING · INDICATING INSTRUMENTS

It will *pay* you to look into *this*.

The Permutit® Deaerator stops corrosion by removing all oxygen and CO_2

This transparent model makes it easy to see why the Permutit Deaerating Heater offers you the easiest, most thorough means of deaerating water for boiler-feed make-up.

Advantages of this equipment are many: It recovers waste heat economically and prevents corrosion of feed lines, stage heaters, economizers, and boilers. Operating noiselessly, it adapts itself readily to different steam pressures. Most important, the Deaerator is simple in design, and requires a minimum of maintenance expense.

Write for full information to the Permutit Company, Dept. ME-10, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

1 FIRST STAGE. Cold water, entering here, is heated almost to steam temperature by spraying it through steam. This removes 95% of the oxygen. The water then travels downward through the pipe toward the second stage.

2 SECOND STAGE. Here the partially deaerated water is intimately mixed with steam entering through the scrubber. Violent boiling and vigorous scrubbing is assured for both light and heavy loads, and deaeration is completed.

3 The steam from the scrubber travels upward and enters the first stage of the heater, where it partially deaerates incoming water. The remaining steam is then vented to the atmosphere.

4 Here the completely deaerated water settles and may be drawn off. Ample water storage space is provided below the water control level.

Permutit

WATER CONDITIONING HEADQUARTERS FOR OVER 37 YEARS

How TIMKEN® bearings help ram-type lathe turn 3/4-ton part

ALTHOUGH this Gisholt No. 5 ram-type lathe normally handles 2½" bar work, it's being used here to machine locomotive axles weighing ¾ of a ton! One reason for this Gisholt lathe's extra capacity: Timken® bearings on the spindle and in the headstock.

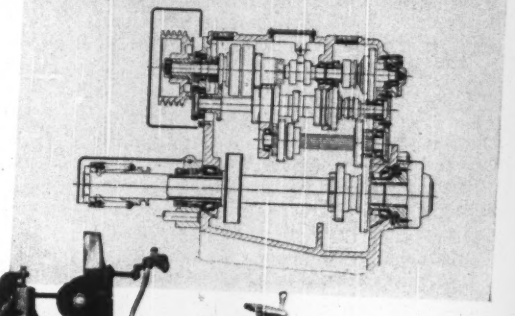
Mounted on Timken tapered roller bearings, Gisholt spindles stay rigid and free of vibration under the heaviest loads. Line contact between the rollers and races of Timken bearings give the spindle maximum support. Deflection or end-movement is minimized. The tapered construction of Timken bearings enables them to carry tremendous thrust as well as radial loads. And it permits pre-loading to any desired degree.

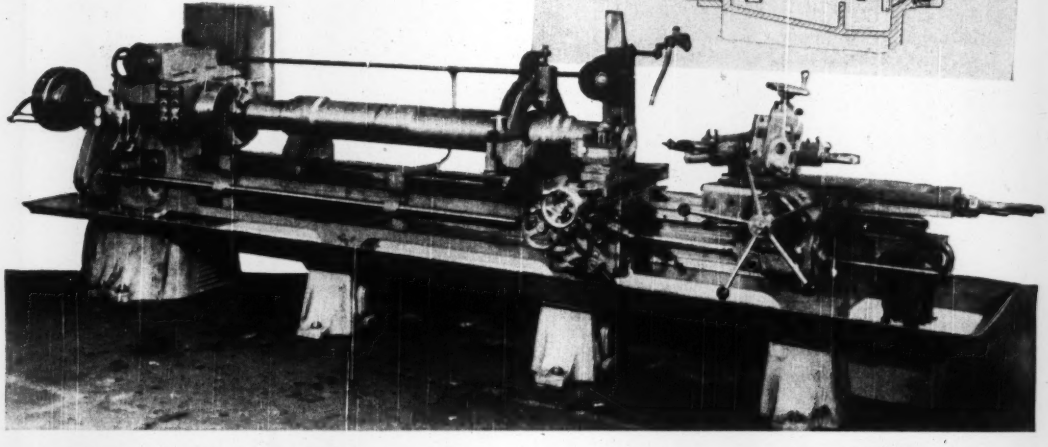
Timken bearings are made of the best steel ever developed for tapered roller bearings—Timken fine alloy steel. The rollers and races are case-hardened for exceptional resistance to wear, and have tough, shock-resisting inner cores. Incredibly smooth surface finish and true rolling motion virtually eliminate friction. And Timken bearings enable spindles and shafts to retain their original accuracy for long years of service.

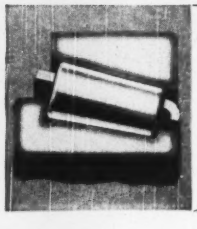
Backed by 50 years of bearing research and development, Timken tapered roller bearings are the No. 1 choice throughout industry. Whether you build or buy, be certain every machine is equipped with Timken bearings. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

THE GISHOLT MACHINE COMPANY *uses Timken bearings on the spindle and throughout the headstock of their ram-type and other lathes, insuring smooth, accurate, vibration-free performance under the heaviest cuts.*







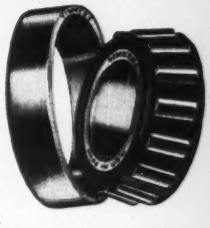
GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer. The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST ◫ LOADS OR ANY COMBINATION ✳